NOTICE OF PROJECT CHANGE

Town of Orleans Comprehensive Wastewater Management Plan (CWMP) Effluent Discharge Location

Submitted to:
Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act Office

Prepared for:
Town of Orleans

October 2018

AECOM
250 Apollo Drive
Chelmsford, MA 01824
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October 30, 2018

Deidre Buckley, Director
Massachusetts Environmental Policy
Act Office
Executive Office of Energy and
Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Re: Notice of Project Change for Town of Orleans Comprehensive Wastewater Management Plan; **EEA#14414**

Dear Ms. Buckley:

On behalf of our client, the Town of Orleans, AECOM respectfully submits the enclosed Notice of Project Change (NPC) in accordance with 301 CMR 11.10(1). One original signed version, one copy of the original, and one electronic version are enclosed for review under the Massachusetts Environmental Policy Act (MEPA) regulations.

The enclosed NPC describes a change to Orleans' Comprehensive Wastewater Management Plan regarding the location of effluent disposal associated with the proposed Wastewater Treatment Facility (WWTF). The location of the discharge is proposed to be moved from the previously proposed discharge location at the former Tri-Town Septage Treatment Facility on Overland Way, and is now instead proposed for discharge at Lots Hollow Way, approximately one mile to the southeast of the WWTF site. Due to a proposed change in discharge technology from the previously proposed rapid infiltration beds to currently proposed wick discharge, the area required for the discharge has decreased, as explained in the enclosed NPC.

The Lots Hollow Road discharge area has been evaluated through a hydrogeologic evaluation, and the results are included in a report provided in Attachment 3, which has been provided to the MassDEP. Due to the size of the hydrogeologic report, which is almost 650 pages long, this document is provided electronically on an enclosed disk, rather than in hard copy. The results of the report are summarized in the text of the enclosed NPC. The entire report will be provided to any individual or agency upon request, in electronic format.

The NPC is being concurrently circulated in accordance with 301 CMR 11.10(7). If you have any questions regarding this NPC, please contact me at (978) 905-2968.

Yours sincerely,

Jennifer Doyle-Breen

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Enclosure
cc: John Kelly, Town of Orleans
George Meservey, Town of Orleans
Thomas Parece, AECOM
NPC Distribution List (see Attachment 5 of NPC)

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Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs ■ MEPA Office

For Office Use Only ***Executive Office of Environmental Affairs***
MEPA Analyst:
Phone: 617-626-

Notice of Project Change

The information requested on this form must be completed to begin MEPA Review of a NPC in accordance with the provisions of the Massachusetts Environmental Policy Act and its implementing regulations (see 301 CMR 11.10(1)).

EEA # 14414		
Project Name: Town of Orleans Comprehensive Wastewater Management Plan		
Street Address: 29 Overland Way; 32 and 43 Lots Hollow Road		
Municipality: Orleans	Watershed: Cape Cod	
Universal Transverse Mercator Coordinates:	Latitude: 41.782646 Longitude: -70.006152	
Estimated commencement date: Spring 2020	Estimated completion date: Spring 2023	
Project Type: Effluent Disposal	Status of project design: 30 %complete	
Proponent: Town of Orleans		
Street Address: 19 School Road		
Municipality: Orleans	State: MA	Zip Code: 02653
Name of Contact Person: Jennifer Doyle-Breen		
Firm/Agency: AECOM	Street Address: 250 Apollo Drive	
Municipality: Chelmsford	State: MA	Zip Code: 01824
Phone: 978-905-2968	Fax: 978-905-2101	E-mail: Jennifer.doyle-breen@aecom.com

With this Notice of Project Change, are you requesting:

a Single EIR? (see 301 CMR 11.06(8)) ☐Yes ☒No

a Special Review Procedure? (see 301CMR 11.09) ☐Yes ☒No

a Waiver of mandatory EIR? (see 301 CMR 11.11) ☐Yes ☒No

a Phase I Waiver? (see 301 CMR 11.11) ☐Yes ☒No

Which MEPA review threshold(s) does the project meet or exceed (see 301 CMR 11.03)?

301 CMR 11.03(5)(a)(3) Wastewater. Construction of one or more new sewer mains ten or more miles in length.

301 CMR 11.03(5)(b)(1) Wastewater. Construction of a new wastewater treatment and/or disposal facility with a capacity of 100,000 gpd or more.

301 CMR 11.03(5)(b)(4)(c)(ii) Wastewater. New discharge to groundwater of 50,000 or more gpd of sewage within any other area.

301 CMR 11.03(11)(b) Areas of Critical Environmental Concern. Project within a designated ACEC.

Which State Agency Permits will the project require?

MassDEP Groundwater Discharge Permit
MassDEP Site Assignment (already exists)
MassDEP Sewer Extension Permit
MassDEP Wetlands Protection Act Local Order of Conditions

Identify any financial assistance or land transfer from an Agency of the Commonwealth, including the Agency name and the amount of funding or land area in acres:

The Town of Orleans has applied for a $45 million State Revolving Fund (SRF) loan for sewering downtown, building the wastewater treatment plan, and building the pipeline for effluent disposal.

PROJECT INFORMATION

In 25 words or less, what is the project change?

The WWTF effluent discharge location has changed from the former Tri-Town Septage Treatment Facility on Overland Way to 32 Lots Hollow Road.

See full project change description beginning on page 3.

Date of publication of availability of the ENF in the Environmental Monitor: (Date: May 6, 2009)

Was an EIR required? ☒Yes ☐No; if yes,
was a Draft EIR filed? ☐Yes (Date:) ☒No
was a Final EIR filed? ☐Yes (Date:) ☒No
was a Single EIR filed? ☒Yes (Date: 12/2010) ☐No

Have other NPCs been filed? ☐Yes (Date(s):) ☒No

If this is a NPC solely for lapse of time (see 301 CMR 11.10(2)) proceed directly to **ATTACHMENTS & SIGNATURES**.

PERMITS / FINANCIAL ASSISTANCE / LAND TRANSFER

List or describe all new or modified state permits, financial assistance, or land transfers not previously reviewed: **dd w/ list of State Agency Actions (e.g., Agency Project, Financial Assistance, Land Transfer, List of Permits)**

None

Are you requesting a finding that this project change is insignificant? A change in a Project is ordinarily insignificant if it results solely in an increase in square footage, linear footage, height, depth or other relevant measures of the physical dimensions of the Project of less than 10% over estimates previously reviewed, provided the increase does not meet or exceed any review thresholds. A change in a Project is also ordinarily insignificant if it results solely in an increase in impacts of less than 25% of the level specified in any review threshold, provided that cumulative impacts of the Project do not meet or exceed any review thresholds that were not previously met or exceeded. (see 301 CMR 11.10(6)) ☐**Yes** ☒**No; if yes, provide an explanation of this request in the Project Change Description below.**

See further explanation below in Section (c) of the Project Change Description.

FOR PROJECTS SUBJECT TO AN EIR

If the project requires the submission of an EIR, are you requesting that a Scope in a previously issued Certificate be rescinded?
☐**Yes** ☒**No; if yes, provide an explanation of this request**_____**.**

If the project requires the submission of an EIR, are you requesting a change to a Scope in a previously issued Certificate?
☐**Yes** ☒**No; if yes, provide an explanation of this request**_____**.**

SUMMARY OF PROJECT CHANGE PARAMETERS AND IMPACTS

Summary of Project Size & Environmental Impacts	Previously reviewed	Net Change	Currently Proposed
LAND			
Total site acreage	27 ac	+5.6 ac*	32.6 ac
Acres of land altered	6.5 ac	-4.58 ac*	1.92 ac
Acres of impervious area	6 ac	-1.97 ac*	4.0 ac
Square feet of bordering vegetated wetlands alteration		0	
Square feet of other wetland alteration		0	
Acres of non-water dependent use of tidelands or waterways		0	
STRUCTURES			
Gross square footage	59,200 sf	0	59,200 sf
Number of housing units	0	0	0
Maximum height (in feet)	25 ft	0	25 ft
TRANSPORTATION			
Vehicle trips per day	26	0	26
Parking spaces	12	0	12
WATER/WASTEWATER			
Gallons/day (GPD) of water use	640,000	0	640,000
GPD water withdrawal	0	0	0
GPD wastewater generation/ treatment	504,000 gpd	0	504,000 gpd
Length of water/sewer mains (in miles)	74 mi	+0.91mi	74.91 mi

***Total site area is increasing due to addition of the 32 and 43 Lots Hollow parcels; however area altered and area of impervious is decreasing due to use of wick wells at these sites, which overall require less area of disturbance to install as compared to previously proposed infiltration beds at Parcels 1/1A on the Tri-Town site, and overall reduction of impact area at 29 Overland Way.**

Does the project change involve any new or modified:

1. conversion of public parkland or other Article 97 public natural resources to any purpose not in accordance with Article 97? ☐**Yes** ☒**No**
2. release of any conservation restriction, preservation restriction, agricultural preservation restriction, or watershed preservation restriction? ☐**Yes** ☒**No**

3. impacts on Rare Species**?** ☒**Yes** ☐**No**

Note: Impacts on Rare Species reduced, as explained in Section (b) below.

4. demolition of all or part of any structure, site or district listed in the State Register of Historic Place or the inventory of Historic and Archaeological Assets of the Commonwealth?

☐**Yes** ☒**No**

5. impact upon an Area of Critical Environmental Concern? ☐**Yes** ☒**No**

If you answered 'Yes' to any of these 5 questions, explain below:

PROJECT CHANGE DESCRIPTION (attach additional pages as necessary). The project change description should include:

(a) a brief description of the project as most recently reviewed

(b) a description of material changes to the project as previously reviewed,

(c) if applicable, the significance of the proposed changes, with specific reference to the factors listed 301 CMR 11.10(6), and

(d) measures that the project is taking to avoid damage to the environment or to minimize and mitigate unavoidable environmental impacts. If the change will involve modification of any previously issued Section 61 Finding, include a draft of the modified Section 61 Finding (or it will be required in a Supplemental EIR).

(a) Brief description of the project as most recently reviewed

The project described in the 2010 CWMP/SEIR included installation of sewers, a wastewater treatment facility (WWTF) and effluent disposal beds within the Town of Orleans. The 2010 CWMP/SEIR figures in Attachment Figure 1 in Appendix A illustrates the previously proposed build condition.

In the 2010 CWMP/SEIR, effluent recharge at the proposed WWTF comprised a series of ten open rapid infiltration basins at the former Tri-Town Septage Treatment Facility site on Overland Way. The initial design capacity of the WWTF would treat and dispose up to 504,000 gpd of effluent. Effluent disposal at the Tri-Town site would result in transport of nitrates to Namskaket and Little Namskaket marshes and to Cape Cod Bay. Approximately 67% of the treated wastewater effluent from the Tri-Town site would discharge to Namskaket Marsh, 9% would discharge to Little Namskaket Marsh, and approximately 25% would discharge to Cape Cod Bay. The CWMP/SEIR concluded that the disposal of treated effluent from the Orleans WWTF would not impact local groundwater and surface water resources including existing water table mound heights and nutrient loading to both the Namskaket Marsh and Little Namskaket Marsh. Analytical and numerical modeling showed that the top of the mound due to the application of wastewater effluent would be no closer than 25 feet below the ground surface, well below the four-foot minimum separation required by DEP.

As described in the CWMP/SEIR, most of the previously proposed Core Program sewer construction was to be located within existing roadway rights-of-ways. The Town's sewer project would not directly impact BVW resources, but it was determined that sewer line routes may encroach in the 100-foot buffers of regulated wetland resource areas and result in impacts to wetland buffer zone area.

The SEIR indicated that the former Tri-Town Septage Treatment Facility site was located within Priority Habitat for the Eastern Box Turtle (*Terrapene carolina)*, the Diamond-backed Terrapin (*Malaclemys terrapin)*, Salt Reedgrass (*Spartina cynosurodies)*, and Mitchell's Sedge *(Carex mitchelliana)*. The Town, in consultation with NHESP, completed an

evaluation of alternative site layouts for the Orleans WWTF during the time of the CWMP/SEIR preparation, including the location of the rapid infiltration beds at the northernmost portion of the site and maximization of reuse of existing disturbed areas and septage facility infrastructure for wastewater treatment. The revised site layout presented in the CWMP/SEIR (see Attachment 1) resulted in the permanent alteration of approximately 4.9 acres of on-site habitat and avoided a 'take' of the Eastern Box Turtle.

(b) Description of material changes to the project as previously reviewed

The material changes to the project since it was previously approved by MEPA include:

- Different effluent discharge location
- Decreased footprint of the WWTF site
- New effluent force main between WWTF site and the new discharge location

These changes are described below.

New Discharge Location

As previously proposed, effluent was to be discharged at the former Tri-Town Septage Treatment Facility and location of the proposed WWTF on Overland Way (parcels 1/1A). An alternative, nearby location is now proposed. The new location for effluent discharge is 32 Lots Hollow Road, which is located south of the Route 6 and Route 6A cloverleaf, approximately 4,840 feet (0.91 miles) from the WWTF. A second site, 43 Lots Hollow Road, is also proposed as a reserve site.

The 32 and 43 Lots Hollow Road sites are less archaeologically sensitive than the previously proposed location of the discharge at Overland Way. In addition, a wick discharge is now proposed instead of discharge via open bed infiltration. The wick discharge requires considerably less area and therefore will result in disturbance to less acreage than previously proposed. In addition the 32 and 43 Lots Hollow Road sites are farther from sensitive Estimated and Priority Habitat mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) as compared to the previous parcel 1/1A site.

The 32 and 43 Lots Hollow Road sites have been evaluated through a hydrogeologic evaluation, and the results are included in a report provided in Attachment 3, which has been provided to the MassDEP Southeast Regional Office for review and comment in regard to the suitability of these sites for effluent discharge.

Based on site conditions, subsurface soils encountered, a wick loading test, and groundwater model results, a minimum of 500,000 gpd can be discharged at either 32 Lots Hollow Road or the reserve location at 43 Lots Hollow Road. The proposed discharge method is series of wicks. The Town expects to install three to four wicks at the site. The number of wicks installed will factor in redundancy in the WWTF discharge capacity as well as the proper operation and maintenance of the wicks. The wick design, number of wicks, and location of the wicks within the discharge area will be submitted to MassDEP as part of the WWTF design documentation.

WWTF Site Decreased Footprint

The proposed work at Overland Way will occur in previously disturbed areas of the site (both for the WWTF and the pipeline). This is a reduction in area proposed for the

Wastewater Treatment Facility site previously proposed (see Figures in Attachments 1 and 2). This change will reduce the impact on priority habitat, as illustrated in Figure 2C and discussed above.

New Effluent Force Main

Phase I of the Core Program is to sewer the Downtown Area, construct the WWTF, and install the effluent disposal. The total length of sewers will be approximately 6.5 miles of the 74 miles total that are projected for the Core Area. In addition to the new sewers, approximately 0.91 miles of new WWTF effluent force main are proposed between Overland Way and the discharge locations at 32 and 43 Lots Hollow Road (Figure 2b in Attachment 2). The effluent pipeline route will exit the site in the area of the previous composting facility, and then will travel along the bike path, below Route 6, and along existing roads to the discharge site at Lots Hollow Road, as shown in Figures 2a and 2b in Attachment 2). The pipe will be installed by open trench cut and cover methods, except for the segment below Route 6 which will be installed by jacking. As was previously reviewed in the CWMP/SEIR, the pipeline will be within existing roads and will not directly impact Bordering Vegetated Wetlands (BVW).

(c) If applicable, the significance of the proposed changes, with specific reference to the factors listed in 301 CMR 11.10(6)

The significance and anticipated impact of the proposed effluent discharge at either 32 or 43 Lots Hollow Road have been evaluated through a hydrogeologic evaluation, and the results are included in Section 6.0 of the report, which is provided as Attachment 3. The report has also been provided to the MassDEP Southeast Regional Office for review and comment in regard to the suitability of these sites for effluent discharge. The potential impacts of the discharge are similar to those previously evaluated for a discharge at Parcels 1/1A at Overland Way, and are summarized below. Also provided below is an evaluation of the factors listed in 301 CMR 11.10(6)

Discharge Water Quality

Discharge from the WWTF is expected to be within water quality standards set by the state. As noted in the model simulations, the effluent discharged will be widely distributed across several watersheds. This is primarily due to the relatively flat water table.

Groundwater Mounding/Wetland Impacts

Based on groundwater model simulations, groundwater mounding would not impact any structures or nearby properties. In general, the average or high water level elevations from groundwater mounding are insignificant and well below surrounding surface levels.

Simulations show that the increase in groundwater elevation in the vicinity of Namskaket and Little Namskaket Creek has the potential to alter the hydrology of the marsh sufficiently to cause a change in vegetation. It is possible that the addition of freshwater input to the marsh could cause a shift from salt marsh to freshwater plant species. These conditions would be particularly favorable to an increase in extent of *Phragmite*s, which already exists in the area. The extent of any vegetation shift is difficult to predict. Therefore, monitoring of the plant species distribution within the eastern/southeastern portion of Namskaket Marsh may be necessary once the discharge commences, in order to document any shifts in plant cover from salt water to freshwater species, including *Phragmites*.

However, over a longer time frame these changes may be dwarfed by the impacts of sea

level rise. A recent study conducted by the US Geological Survey indicated that as a result of sea level rise, groundwater levels on Cape Cod are predicted to rise as high as 2.11 feet, with a more nominal rise of 0.1 foot near inland streams. Given these predictions, it is likely that any effect of the groundwater mounding predicted to occur as a result of the proposed groundwater discharge would be minimal compared to changes likely to occur as a result of sea level rise over a longer period.

None of the pipeline route from the WWTF to the Lots Hollow Road parcels is in wetlands or buffer zones.

Watershed Nitrate Loads

The elimination of septic systems will result in long-term improvements in groundwater quality. No significant short-term impacts on surface water quality are expected. It is likely that improvement in groundwater quality will eventually lead to better surface water quality, as groundwater moves from inland areas to coastal discharge areas, or toward ponds from tributary areas. When most of the effluent-impacted groundwater eventually emerges in coastal waters, it would do so sufficiently offshore, and in sufficiently well-mixed areas. The emergence of effluent-impacted groundwater to the coastal waters would occur many years after the initiation of treatment and disposal activities.

The modelling results indicate that freshwater flow and nitrate load from the discharged effluent will eventually reach Cape Cod Bay, Little Namskaket Creek (MA 96-26), Namskaket Creek (MA 96-27), and Town Cove (MA 96-68), as well as a smaller proportion discharging to Rock Harbor (MA96-16) and Boat Meadow River (MA 95-15). However, the discharge plume will not reach these receiving water bodies for approximately 100 years.

Cape Cod Bay and Boat Meadow River have not been evaluated by the Massachusetts Estuaries Project (MEP), but Namskaket and Little Namskaket Marsh, Rock Harbor, and Town Cove are all evaluated in MEP reports that identify nitrogen loading thresholds based on hydrodynamic and water quality modelling of these estuarine systems. The MEP modelling analysis of both the Namskaket and Little Namskaket marsh systems indicates they are still able to assimilate additional nitrogen, without adverse water quality and benthic habitat impacts. The MEP analysis indicates that Rock Harbor and Town Cove cannot assimilate additional nitrogen without adverse water quality and benthic habitat impacts, and that the existing nitrogen loads are already in excess of the target watershed loads for maintaining a healthy aquatic ecosystem. The residual nitrogen remaining after treatment at the Lots Hollow sites will increase the nitrogen loading to both Namskaket Marsh and Little Namskaket Marsh, but the loading would still be below their respective MEP nitrogen load target. The nitrogen loading to the Town Cove and Rock Harbor sub-watersheds will be reduced as a result of the proposed discharge, which will benefit these receiving waters that are already impaired for nutrients and adversely affected by current nitrogen loading.

Increased Freshwater Flow to Watersheds

Similar to the previously proposed discharge, the proposed new discharge location would result in additional freshwater flow to receiving estuaries. Due to the nature of marsh soils, a majority of the increased flow would likely enter the marshes through the stream channels where the greatest stream flow occurs due to tidal flux. The percentage of increased flow to the estuaries is relatively low. The estuaries with the greatest flow are tidal creeks that would discharge most of the additional freshwater with each tidal cycle. Outside the potential for groundwater mounding impacts discussed above, the additional

freshwater flow is not expected to impact on the estuaries. The following table summarizes previously approved and currently proposed freshwater flow to watersheds.

Table 1. Percent of Estimated Freshwater Flows to Receiving Watersheds

Watershed	2010 CWMP/SEIR	Proposed 32/43 Lots Hollow (500,000 gpd)
Namskaket Creek	67%	13%
Little Namskaket Marsh	9%	0%
Little Namskaket Creek	9%	2%
Rock Harbor		2%
Boat Meadow River		2%
Town Cove (in Nauset Marsh)		11%
Other		29%
Cape Cod Bay		20%
Pleasant Bay		21%

Potential Impacts to Coastal Resources

The groundwater mound and effluent discharge would occur within the Inner Cape Cod Bay Area of Critical Environmental Concern (ACEC), which includes Cape Cod Bay, both Namskaket and Little Namskaket Creeks, Boat Meadow River, and Rock Harbor up to the 10-foot elevation contour. Because of the depth of effluent disposal the majority of effluent will travel beneath coastal resources (beaching and associated swimming areas, commercial and recreational shell fishing areas, marine/estuarine habitat) to be mixed with waters sufficiently offshore where substantial tidal flushing will occur. The treatment and disposal of sewage through the proposed groundwater discharge rather than the continued use of on-site septic systems is expected to result in an overall improvement to water quality, which would benefit all coastal resources. Thus the discharge is not expected to adversely affect the ACEC functions.

Potential impacts to Rare and Endangered Species

According to the MassGIS data layers, Cape Cod Bay, the area of Namskaket and Little Namskaket Creek marshes and adjacent streams, Rock Harbor and Town Cove are all mapped as Priority Habitat (polygon PH 945). Town Cove is also mapped as Estimated Habitat. No adverse water quality impacts are anticipated to occur to any of the receiving waters, and therefore there are not expected to be any water quality impacts to any protected species. In addition, the groundwater effluent is not expected to reach the estuaries for approximately 100 years.

Consultation with the Massachusetts Natural Heritage and Endangered Species Program

(NHESP) during the preparation and submittal of the 2010 Comprehensive Wastewater Management Plan (CWMP) determined that Priority Habitat for four species protected under the Massachusetts Endangered Species Act (MESA) was present at the Tri-Town Septage Treatment Facility site. Effluent disposal is no longer proposed at this site; however the proposed discharge at Lots Hollow Road is relatively close to the Tri-Town Septage Treatment Facility site. The four species identified at the Tri-Town site were: the Eastern Box Turtle (*Terrapene carolina*, the Diamond-backed Terrapin (*Malaclemys terrapin*), Salt Reedgrass (*Spartina cynosuroides*), and Michell's Sedge (*Carex mitchelliana*). During more recent discussions, MA NHESP indicated that the area west of the Tri-Town site was potential habitat for two state listed plant species. Thus, as with the previously proposed discharge location, the predicted mound from a discharge at the Lots Hollow site may extend to areas including habitat for any of these species and potentially others. The Town will consult with MA NHESP as needed during the permitting phase of the project to identify and mitigate any potential impacts.

Public Water Supplies

Proposed groundwater discharge is not expected to have an impact on the groundwater supplies of Orleans or Harwich. Under a modelling scenario with a 500,000 gpd discharge and the water supply wells pumping at 2002 average rates or 2020 projected rates, neither particle traces representing the landfill plume nor the groundwater discharge move toward the pumping water supply well.

Private Wells

There are no known sensitive receptors directly downgradient of the discharge with the exception of potential private water supply wells, according to Town records. If wells exist and they are used for drinking water or irrigation, the Town may need to connect these to the public water supply as the wells may be in the influence of the discharge.

Factors listed 301 CMR 11.10(6)

(a) *Expansion of the Project*

The only expansion of the project is the additional length of effluent force main, due to the change in location of the effluent disposal site from Parcel 1/1A at Overland Way to 32/43 Lots Hollow Road. However, this represents a less than 10% change in sewer main length. The proposed effluent force main is approximately 0.9 miles in length, which is approximately one percent of the total sewer main originally proposed. Furthermore, the WWTF site and associated effluent disposal disturbance has decreased in area due to the replacement of the rapid infiltration bed discharge technology with a wick discharge.

(b) Generation of further impacts

Changing the discharge location from Overlay Way to 32 Lots Hollow will not increase the release or emission of pollutants or contaminants. The proposed discharge volume is the same as previously reviewed.

(c) Change in expected date for commencement of the project, commencement of construction, completion date for the project, or schedule of work on the project.

Construction of Phase I of the previously approved Core Program was anticipated to be completed in 2017. Phase II was anticipated to be completed in 2032. Phase 1 of the Core Program is now proposed to commence in the spring of 2020 and to be completed in the

spring of 2023. Although the Phase I completion date is later than originally anticipated, water quality benefits associated with the project will still be achieved.

(d) Change of the project site

The proposed location of effluent disposal has been changed from the location of the former Tri-Town Septage Treatment Facility (parcel 1/1A) on Overland Way to 32/43 Lots Hollow Road. As described above, this will result in some changes to the groundwater flow and nitrate loading in subwatersheds. However, overall the project will still benefit water quality of receiving waters. Furthermore, the change in project site will reduce area of surface disturbance in general, and reduce alteration of areas near MA NHESP mapped priority habitat as well as sensitive archaeological areas. No additional wetland impacts are anticipated as a result of the change in project site.

(e) New application for a permit or new request for financial assistance or a land transfer

There are no new applications or financial assistance requests not previously identified and reviewed in the CWMP/SEIR.

(f) For a project with net benefits to environmental quality and resources or public health, any change that prevents or materially delays realization of such benefits

This project has net benefits to the environment. The proposed change in effluent discharge location will not prevent or materially delay realization of these benefits.

(g) Lapse of time

Not Applicable.

(d) Measures that the project is taking to avoid damage to the environment or to minimize and mitigate unavoidable environmental impacts. If the change will involve modification of any previously issued Section 61 Finding, include a draft of the modified Section 61 Finding (or it will be required in a Supplemental EIR).

The previously reviewed CWMP/SEIR identified measures to avoid damage to the environment or minimize and mitigate unavoidable environmental impacts, as summarized below. The change will not involve modification of any previously issued mitigation measures or Section 61 Finding. Mitigation measures that will be employed either during the construction period and once the facility is operational include:

- Restricting sewer construction work to the period of September to May to avoid periods of high traffic;
- Segmenting sewer work on public streets to avoid protracted closures;
- Designing sewer lines and pump stations to avoid floodplains and to minimize encroachment on the buffers of wetlands and other protected resource areas;
- Restricting work hours on construction sites near residential areas;
- Requiring contractors to implement dust control measures;
- Erosion and siltation controls at all construction sites as part of site-specific stormwater management plans;
- Compliance with all terms of Orders of Conditions for work in wetland buffers;

- Installation of odor and noise control systems on operating equipment and facilities;
- Implementation of policies that restrict potential odor-generating activities to times of the day with the least impact;
- Compliance with applicable standards for construction activities near historic structures;
- Facility siting to avoid, minimize, and mitigate impacts to habitat of rare and endangered species, including compliance with all NHESP conditions;
- Facility site design to include vegetated berms and to maximize natural buffers;
- Selection of wastewater treatment equipment to minimize energy use and maximize nitrogen removal; and
- Adoption of bylaws and regulations to ensure a "growth neutral" program.

ATTACHMENTS & SIGNATURES

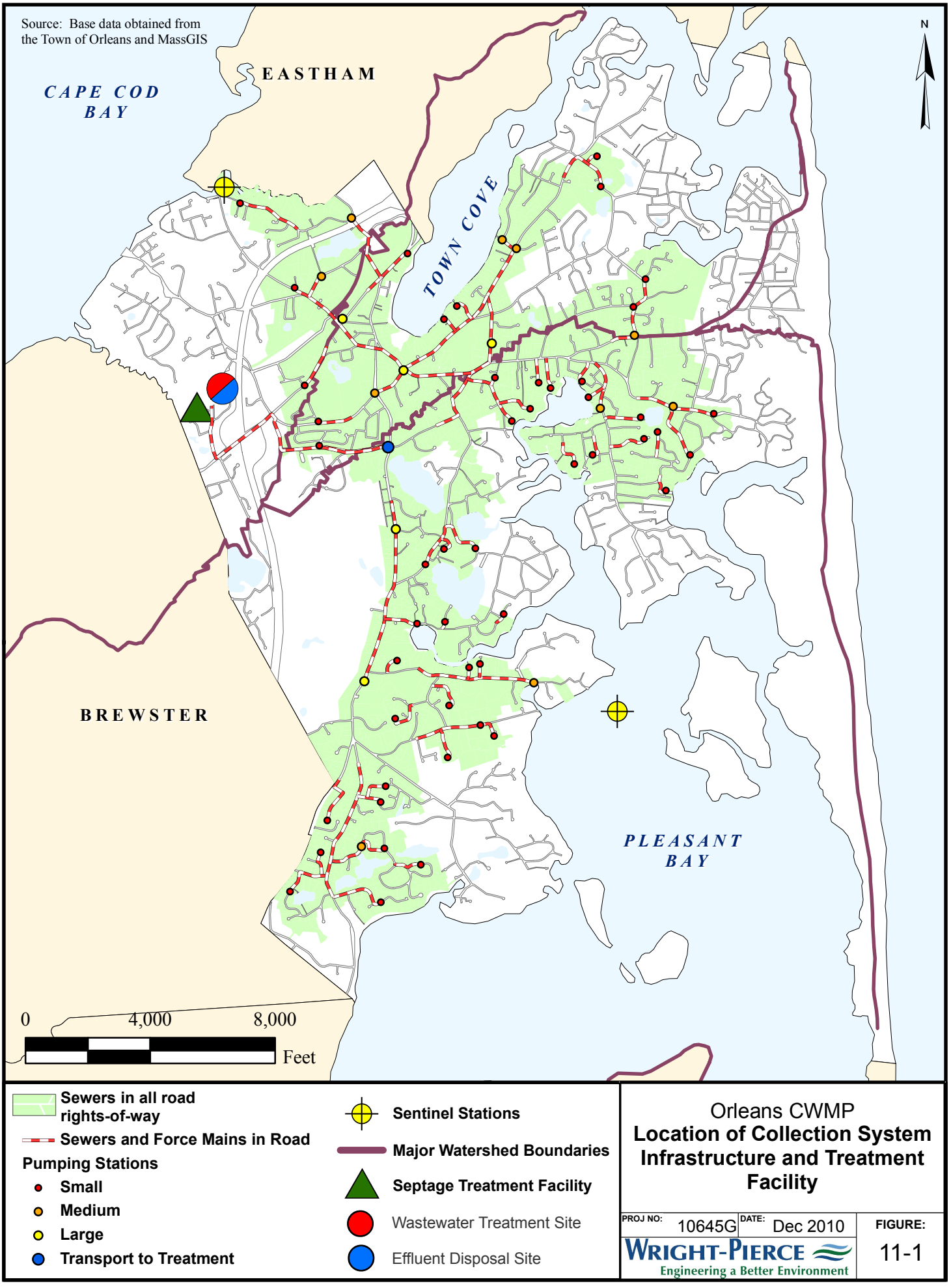
Attachments:
1. Secretary's most recent Certificate on this project
2. Plan showing most recent previously-reviewed proposed build condition
3. Plan showing currently proposed build condition
4. Original U.S.G.S. map or good quality color copy (8-1/2 x 11 inches or larger) indicating the project location and boundaries
5. List of all agencies and persons to whom the proponent circulated the NPC, in accordance with 301 CMR 11.10(7)

Signatures:

10/30/18	10/30/18
Date Signature of Responsible Officer or Proponent	Date Signature of person preparing NPC (if different from above)
John Kelly	Jennifer Doyle-Breen
Name (print or type)	Name (print or type)
Town of Orleans	AECOM
Firm/Agency	Firm/Agency
19 School Rd	250 Apollo Drive
Street	Street
Orleans, MA 02653	Chelmsford, MA 01824
Municipality/State/Zip	Municipality/State/Zip
(508) 240-3700 x 415	(978) 905-2968
Phone	Phone

ATTACHMENT 1

Previously Reviewed Proposed Build Condition



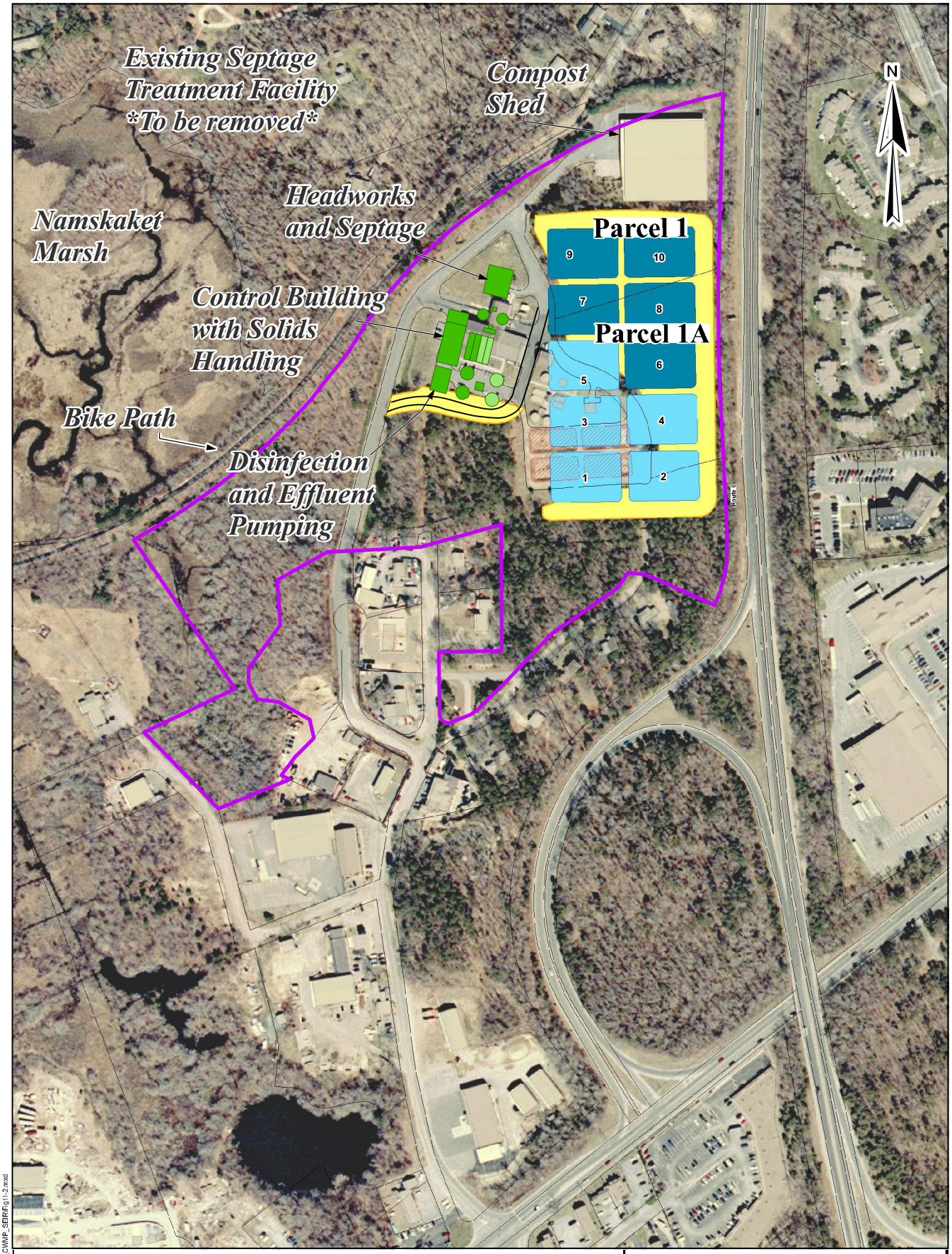
Orleans CWMP

Location of Collection System Infrastructure and Treatment Facility

PROJ NO:	DATE:	FIGURE:
10645G	Dec 2010	11-1

WRIGHT-PIERCE
Engineering a Better Environment

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Proposed Disposal Basins
- Phase 1
- Phase 4/5

Proposed Wastewater Treatment Plant
- Phase 1
- Phase 4

- Tri-Town Property Line
- Existing Buildings
- Existing Disposal Beds
- Disturbed Area

0 100 200 300 400 Feet

Orleans CWMP

Proposed Wastewater Treatment and Disposal Facilities

PROJ NO:	DATE:	FIGURE:
10645G	Dec 2010	11-2

WRIGHT-PIERCE Engineering a Better Environment

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ATTACHMENT 2

Currently Proposed Build Condition

Town of Orleans, MA
Water Quality and Wastewater Planning Services

Figure 2a:
2018 Downtown Service Area
Proposed Collection System Layout

Legend

- Proposed Gravity Sewer
- Existing Gravity Sewer
- Properties proposed to be served by LPS
- PS Forcemain
- WWTF Effluent Forcemain
- Proposed LPS
- Downtown Service Area

Flood Zone Designations

- AE: 1% Annual Chance of Flooding, with BFE
- VE: High Risk Coastal Area

0 300 600
Feet

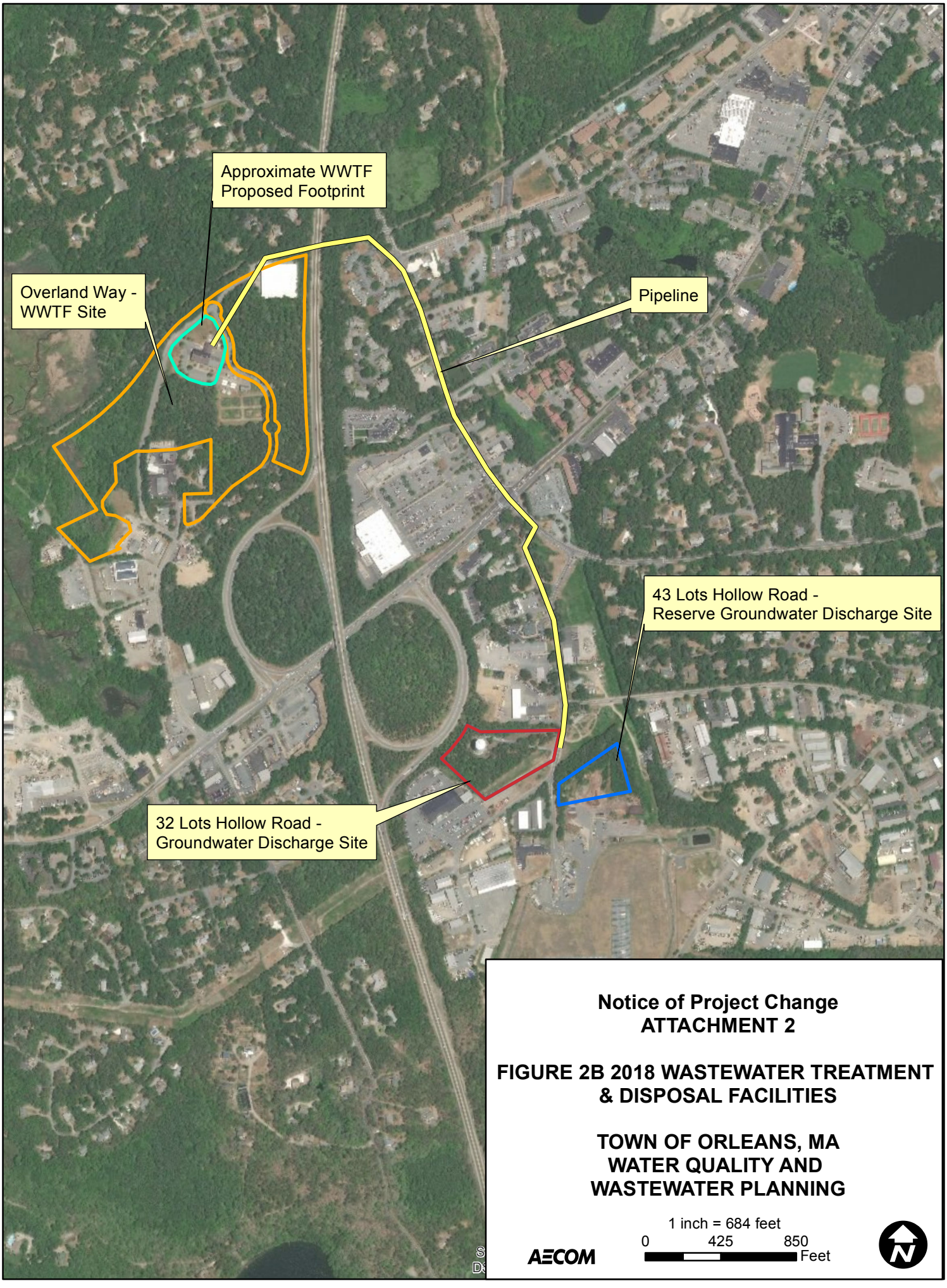
AECOM
October 2018

Proposed Route 6 Crossing
Vicinity of Proposed Namskaket Pump Station
Proposed Wastewater Treatment Facility Project Area
32 Lots Hollow Rd (Water Tower Site) Proposed Effluent Disposal Area
43 Lots Hollow Rd
Vicinity of Proposed Nauset Pump Station
Vicinity of Proposed Snow Pump Station

Namskaket Marsh
Cedar Pond
Boland Pond
Town Cove

ORLEANS
EASTHAM
BREWSTER
ORLEANS

ROUTE 6
ROUTE 6A
ROUTE 28
CAPTAIN DOANES WAY
HARBOR HILL ROAD
ELLIS ROAD
FRONTAGE ROAD
CEDAR POND ROAD
JOSES ROAD
CANAL ROAD
LOCUST ROAD
LIBERTY LANE
KINGS WAY
CHILDS HOMESTEAD ROAD
CHASE LANE
MAIN STREET
OLD COUNTY ROAD
COTTAGE STREET
OLD COLONY WAY
COVE ROAD
DOANE TERRACE
CUMMINGS ROAD
BREWSTER CROSS ROAD
CENTER PLACE
ACADEMY PLACE
OLD COLONY ROAD
WEST ROAD
OAK RIDGE LANE
RAMP-RT 6 WB TO RT 6A
RAMP-RT 6A TO RT 6 ER
LOTS HOLLOW ROAD
ELDREDGE PARK WAY
NICKERSON ROAD
OLD FARM ROAD
TONSET ROAD
SCHOOL ROAD
LONGVIEW DRIVE
BAY RIDGE ROAD
HOLLOW ROAD



Notice of Project Change
ATTACHMENT 2

FIGURE 2B 2018 WASTEWATER TREATMENT & DISPOSAL FACILITIES

TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING

1 inch = 684 feet
0 425 850 Feet

AECOM

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Town of Orleans, MA
Water Quality and Wastewater Planning Services

Figure 2C: Protected Resources Near 2018 Downtown Service Area, WWTF and Disposal Facilities

Legend

- Proposed Gravity Sewer
- Existing Gravity Sewer
- Properties proposed to be served by LPS
- PS Forcemain
- WWTF Effluent Forcemain
- Proposed LPS
- Downtown Service Area
- Areas of Critical Environmental Concern
- NHESP Priority Habitats of Rare Species

Flood Zone Designations

- AE: 1% Annual Chance of Flooding, with BFE
- VE: High Risk Coastal Area

0 300 600
Feet

AECOM
October 2018

Proposed Route 6 Crossing

Vicinity of Proposed Namskaket Pump Station

Proposed Wastewater Treatment Facility Project Area

32 Lots Hollow Rd (Water Tower Site) Proposed Effluent Disposal Area

43 Lots Hollow Rd

Vicinity of Proposed Nauset Pump Station

Vicinity of Proposed Snow Pump Station

BREWSTER

ORLEANS

EASTHAM

Cedar Pond

Boland Pond

Town Cove

ROUTE 6

ROUTE 6A

ROUTE 28

CAPTAIN EDOANES WAY

HARBOR HILL ROAD

ELLIS ROAD

FRONTAGE ROAD

CHASE LANE

KINGS WAY

CHILDS HOMESTEAD ROAD

CEDAR POND ROAD

JOSES ROAD

CANAL ROAD

LOCUST ROAD

LIBERTY LANE

MAIN STREET

OLD COUNTY ROAD

COTTAGE STREET

OLD COLONY WAY

COVE ROAD

DOANE TERRACE

CUMMINGS ROAD

BREWSTER CROSS ROAD

CENTER PLACE

ACADEMY PLACE

TONSET ROAD

SCHOOL ROAD

OLD FARM ROAD

ELDREDGE PARK WAY

NICKERSON ROAD

LOTS HOLLOW ROAD

WEST ROAD

OAK RIDGE LANE

RAMP AT 6WB TO RT 6A

RAMP AT 6A TO RT 6 ER

BAY RIDGE ROAD

BOG HOLLOW ROAD

LONGVIEW DRIVE

ATTACHMENT 3

2018 Groundwater Discharge Hydrogeologic Evaluation 32 and 43 Lots Hollow Road

Provided on a CD to MEPA due to large size of document (approximately 640 pages). The entire report is available upon request and can be provided by a file transfer or CD to requesting individuals or agencies. A copy has already been provided to MassDEP.

GROUNDWATER DISCHARGE HYDROGEOLOGIC EVALUATION 32 AND 43 LOTS HOLLOW ROAD TOWN OF ORLEANS, MASSACHUSETTS

Prepared for:
Town of Orleans
19 School Road
Orleans, Massachusetts 02653

Prepared by:
AECOM Technical Services, Inc.
9 Jonathan Bourne Drive
Pocasset, Massachusetts 02559

August 2, 2018

Project No. 60476644

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1. INTRODUCTION AND BACKGROUND

The Hydrogeologic Evaluation Technical Memorandum documents the approach used to evaluate 32 and 43 Lots Hollow Road (Figure 1) for a groundwater discharge from the proposed Downtown Area wastewater treatment facility (WWTF). This report includes the following:

- Description of the initial steps taken in the process of evaluating groundwater discharge sites;
- Summary of existing data that is available to help evaluate the 32 and 43 Lots Hollow Road site;
- Summary of field investigations conducted at 32 and 43 Lots Hollow Road site;
- Evaluation of field investigations and other available data;
- Results of groundwater flow modeling and groundwater mounding analysis; and
- Recommended maximum discharge capacity for the 32 and 43 Lots Hollow Road site.

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2. PROPOSED COLLECTION, TREATMENT, AND DISCHARGE FACILITIES

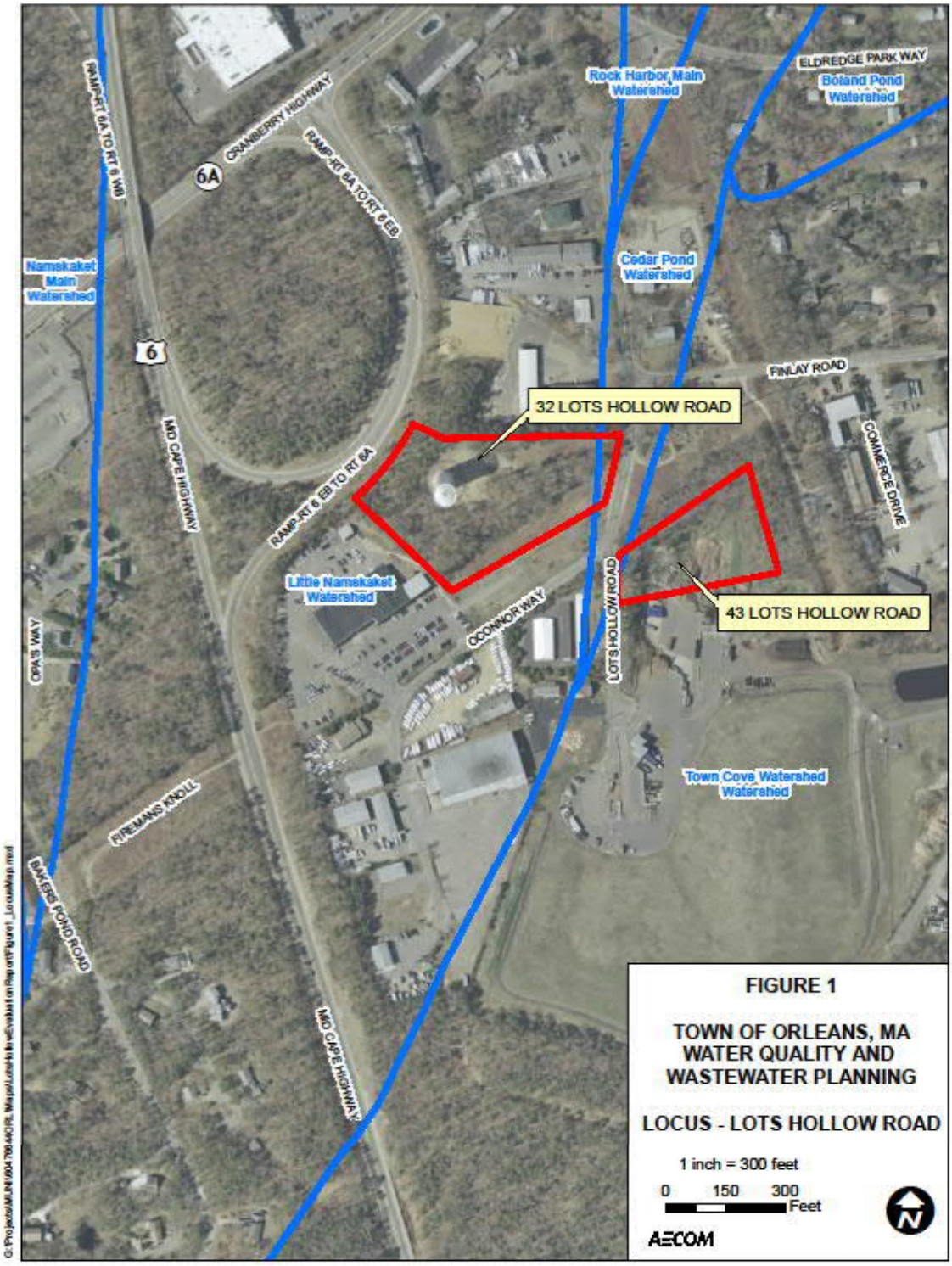
2.1. Collection Area and WWTF

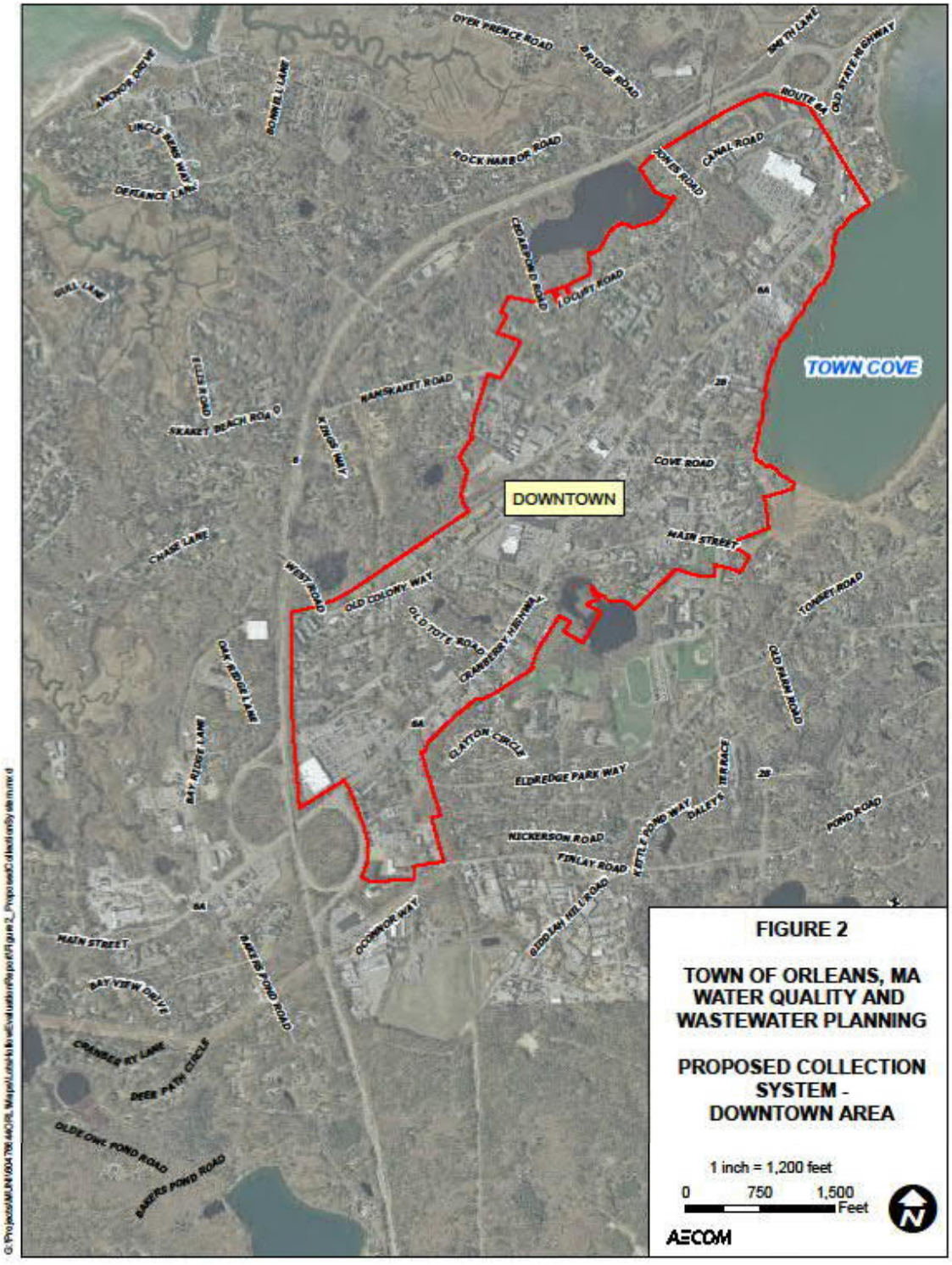
The Massachusetts Estuaries Project (MEP) estimates that approximately 7,000 kilograms per year (kg/yr) of nitrate load from existing and future septic load will need to be removed from the Town Cove Watershed to meet the nutrient load reduction target for Town Cove. The Orleans Water Quality Advisory Panel (OWQAP) evaluated traditional and non-traditional nutrient reduction technologies for nitrate removal within the watershed. Due to the significant nitrate load removal within the Town Cove Watershed, the OWQAP proposed to manage a significant portion of the nitrate load through the construction of wastewater collection, treatment, and disposal facilities in the Consensus Plan. Flow from the collection area will be primarily residential and commercial. Flows are estimated at 150,000 gallons per day (gpd) initially and approximately 250,000 gpd at build out. The proposed collection area is shown on Figure 2. The method of treatment is also being evaluated although a sequencing batch reactor (SBR) facility is considered likely.

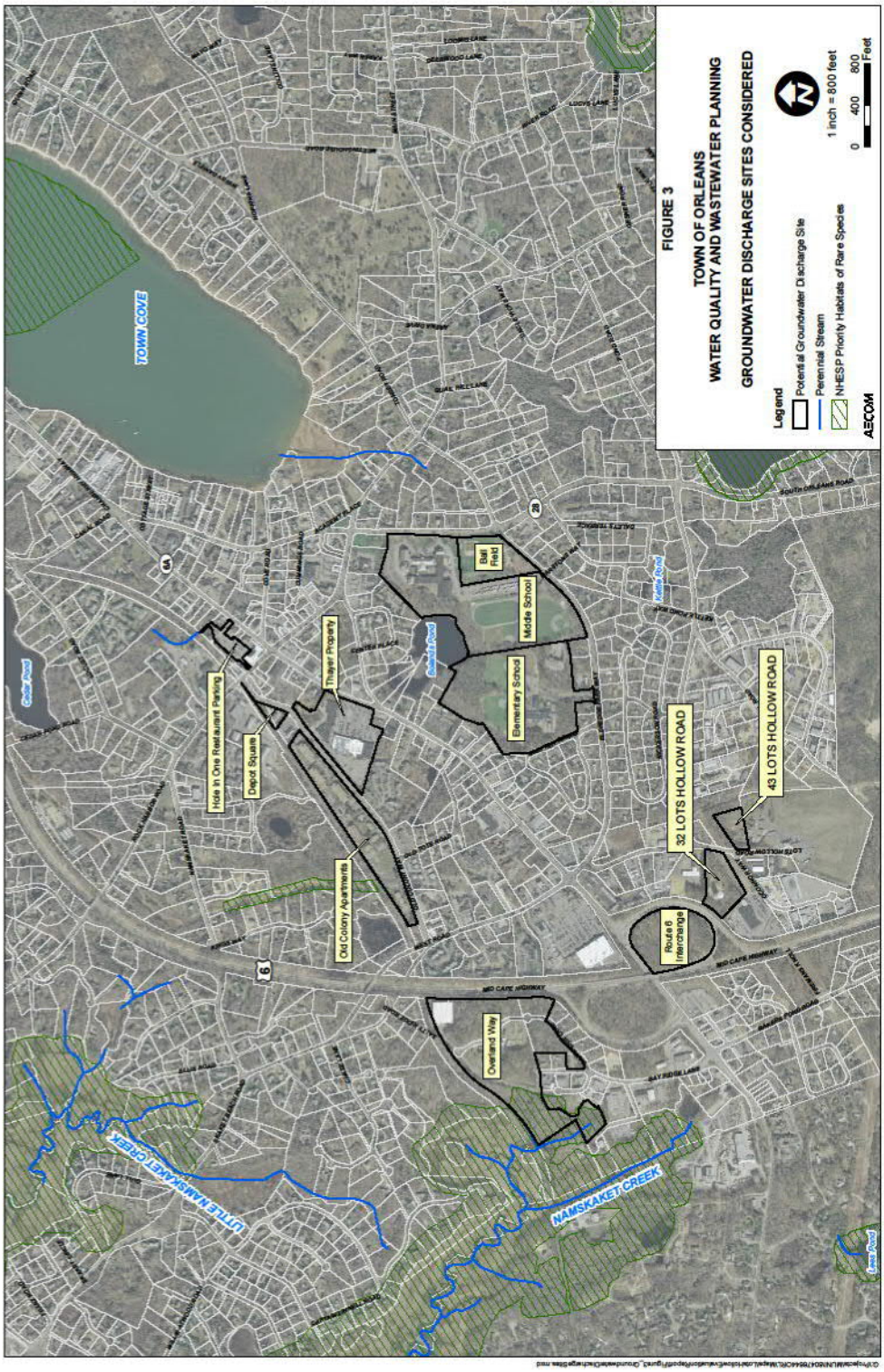
2.2. Initial Discharge Sites Considered

Nine potential locations (Figure 3) for groundwater discharge of wastewater treatment facility effluent were considered in 2016. These sites include:

- Overland Way (Parcels 1/1A);
- Route 6 (Exit 12);
- Thayer Property (Orleans Market Place);
- Old Colony Apartments (Old Colony Way);
- Hole in One Restaurant Parking (Cranberry Highway);
- Depot Square (Old Colony Way);
- Orleans Elementary (46 Eldredge Park Way);
- Nauset Regional Middle School (70 Eldredge Park Way); and
- Orleans Firebirds Baseball Field (80 Eldredge Park Way).


RAMP RT 6A TO RT 6 WB
CRANBERRY HIGHWAY
6A
RAMP RT 6A TO RT 6 EB
Rock Harbor Main Watershed
ELDREDGE PARK WAY
Boland Pond Watershed
Namskaket Main Watershed
Cedar Pond Watershed
6
FINLAY ROAD
32 LOTS HOLLOW ROAD
MID CAPE HIGHWAY
COMMERCE DRIVE
RAMP RT 6 EB TO RT 6A
Little Namskaket Watershed
43 LOTS HOLLOW ROAD
O'CONNOR WAY
LOTS HOLLOW ROAD
OPA'S WAY
Town Cove Watershed Watershed
FIREMANS KNOLL
BAKERS POND ROAD
MID CAPE HIGHWAY
FIGURE 1
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
LOCUS - LOTS HOLLOW ROAD
1 inch = 300 feet
0 150 300
Feet
AECOM


TOWN COVE
DOWNTOWN
MAIN STREET
COVE ROAD
ROCK HARBOR ROAD
CANAL ROAD
ROUTE 6A
OLD STATE HIGHWAY
OLD COLONY WAY
WEST ROAD
NAMSKAKET ROAD
ELDREDGE PARK WAY
NICKERSON ROAD
FINLAY ROAD
POND ROAD
TONSET ROAD
OLD FARM ROAD
BAKERS POND ROAD
FIGURE 2
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
PROPOSED COLLECTION
SYSTEM -
DOWNTOWN AREA
1 inch = 1,200 feet
0
750
1,500
Feet
AECOM


FIGURE 3
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
GROUNDWATER DISCHARGE SITES CONSIDERED
Legend
Potential Groundwater Discharge Site
Perennial Stream
NHESP Priority Habitats of Rare Species
1 inch = 800 feet
0 400 800 Feet
AECOM
TOWN COVE
32 LOTS HOLLOW ROAD
43 LOTS HOLLOW ROAD
Middle School
Elementary School
Ball Field
Thayer Property
Depot Square
Hole In One Restaurant Parking
Old Colony Apartments
Overland Way
Route 6 Interchange
MID CAPE HIGHWAY
NAMSKAKET CREEK
LITTLE NAMSKAKET CREEK

A Site Selection Matrix was developed for the Town by AECOM for objective evaluation of selected discharge sites. The Matrix includes criteria for site suitability, permitting, project evaluation and other/overriding considerations. Site suitability criteria address environmental, land use and implementation features of the proposed discharge locations. Permitting criteria assess regulatory requirements and potential conflicts related to the proposed discharge locations. Project evaluation criteria evaluate the benefits gained from a proposed discharge site. The site selection screening was based on data available at the time of the screening process.

AECOM collected site specific information for each, conducted site visits, and evaluated the potential performance effectiveness. A rating system was then developed to quantify how well each site met a specific criterion. The point-based system used is as follows.

The Site Selection Matrix includes the following criteria that can be understood from currently available information and excluding hydrogeology which will be the subject of the investigations:

2.2.1. Site Suitability

- Property Ownership – Town owned, open space, privately owned, developed, undeveloped,
- Distance from wastewater treatment facility – The length of the force main and route it would follow must be installed significantly affecting overall costs.
- Ease of Access/Use of Property – Whether the discharge area is in an open area, under an existing parking lot, or in a developed area can affect the size and cost of the discharge area as well as installation and maintenance costs.
- Site Topography - Significant changes in elevation may affect construction and monitoring.
- Present Use of Site – Developed sites may be difficult to gain an easement agreement or right-of-way for a groundwater discharge.
- Potential Use of Site – Sites that are zoned or slated for future development may be more difficult to get permission to access and can impact the purchase price of parcel or alter the value of Town owned land.
- Depth to Groundwater - Deeper water table increases costs and may affect feasibility.
- Subsurface Soils Profile – Finer, lower transitivity soils (silt and clay) between the ground surface and 20 feet or so below the groundwater table can limit the amount of groundwater that can be discharged as well as the method of discharge (open bed, subsurface, wick, etc.).
- Area Available for Groundwater Discharge – Smaller discharge areas limit the amount of groundwater discharge potentially requiring discharge infrastructure at several locations.
- Downgradient Water Use – Public water supply or potable water supply wells are located nearby or down gradient.

2.2.2. Permitting

- Potential for Watershed/Estuary Impacts - Distance from surface water and wetland resource areas/water use considerations.
- Potential Impacts to Areas of Critical Environmental Concern (ACEC).
- Presence of Rare and Endangered species.

2.2.3. Project Evaluation

- Watershed total maximum daily load (TMDL) – Discharging to a watershed with a nitrate total maximum daily load may require higher treatment levels at the wastewater treatment facility significantly increasing capitol and O&M costs.
- Conclusion of Previous Studies – The quality and conclusion of previous studies can impact the tasks necessary to perform the required Massachusetts Department of Environmental Protection (MassDEP) Hydrogeologic Evaluation.
- Required Effluent Discharge Quality – Site specific and surrounding conditions can impact required wastewater treatment facility discharge quality such as disinfection, nitrate levels, etc.
- Groundwater Discharge Method(s) – Capital and O&M costs for groundwater discharge methods vary. Site conditions can impact what discharge methods can be used.

2.2.4. Site Review and Shortlisted Sites

Site review and the site suitability evaluation process resulted in the following ranking of sites:

- Overland Way (Sites 1/1A) – 13 Points
- Route 6 (Exit 12) – 8 Points
- Depot Square (Old Colony Way) – 5 Points
- Old Colony Apartments (Old Colony Way) – 5 Points
- Thayer Property (Orleans Market Place) – 1 Point
- Hole in One Restaurant Parking (Cranberry Highway) – 1 Point

The above groundwater discharge sites were reviewed by the Town of Orleans Selectmen at an open meeting on Wednesday December 14, 2016. Two locations were initially shortlisted for hydrogeologic evaluation; Route 6 (Exit 12) and Overland Way. Reports on these sites were submitted to MassDEP in October and June of 2017, respectively.

2.3. Subsequent Discharge Sites Considered - Lots Hollow Road

This document reviews 32 and 43 Lots Hollow Road for potential groundwater discharge sites (Figure 1). These sites were not being considered at the time of the Site Selection Matrix was developed and were thus not scored and ranked.

The 32 and 43 Lots Hollow Road sites are being considered for two primary reasons. First, the site is located relatively close to the proposed WWTF at Overland Way; second, the 32 Lots Hollow site is located outside the Town Cove Watershed allowing for removal of the nitrate load from that nitrate impacted watershed under most discharge scenarios. The focus of this report is the hydrogeologic evaluation that was performed at the 32 and 43 Lots Hollow Road sites including the groundwater model results resulting from the calibrated groundwater model.

On January 12, 2018 a proposed scope of work to conduct a Hydrogeologic Site Evaluation was submitted to MassDEP for review and comment. The notification of the proposed scope of work was published in Volume 89, Issue 6 on January 24, 2018 of the Environmental Monitor and was open to public comment. Copies of the proposed Hydrogeologic Evaluation scope of work and Environmental Monitor Notification are provided in Appendix A.

The following Technical Memorandum reports on the scope of work, methodology, findings, conclusions, and recommendations of the 32 and 43 Lots Hollow Road Hydrogeologic Evaluation.

3. HYDROGEOLOGIC INVESTIGATION

Results of the hydrogeologic investigation of 32 and 43 Lots Hollow Road are included in the following sections. AECOM's investigations included the installation of soil borings and monitoring wells, grain-size analysis of soil samples, the installation of pumping wells to perform aquifer pumping tests, and the installation and testing of a small diameter "test" wick,. The data obtained were used to evaluate subsurface conditions (i.e. soils), estimate the groundwater flow direction, estimate hydraulic conductivity values, and to characterize the aquifer's response to loading the test wick. Results of the field investigations and data analysis were then used to modify the USGS Monomoy Lens groundwater model. Once modified, the groundwater flow model was used to simulate groundwater flow across the site and regionally, estimate groundwater mounding, and estimate the nitrate load to watersheds under various discharge scenarios (Section 5). A summary of these investigations follows.

3.1. Previous Subsurface Investigations

Prior to AECOM's hydrogeologic evaluation, few detailed site investigations had been performed at the site. Regionally, in the early 1990s, the Cape Cod Commission (CCC) investigated soils, water level and water quality data across the Town of Orleans. The CCC gathered existing soil boring and water level data from numerous previous investigations. The CCC also installed numerous additional soil borings and monitoring wells to evaluate soil and groundwater elevations throughout Orleans. Once collected, data was summarized in a report titled "Orleans Water Table Mapping Project, Orleans Massachusetts", dated May 1995. Soil boring logs, water level and groundwater elevation data, well location maps, geologic cross-sections and groundwater contour maps are included in the report. At 43 Lots Hollow Road, the Town of Orleans installed several monitoring wells to evaluate groundwater quality originating from the capped refuse, former septage lagoons, and compost area at the Town's landfill. Historic water level and water quality data from the monitoring wells was used to evaluate groundwater quality and to estimate the groundwater flow direction at and near 32 and 43 Lots Hollow Road.

3.2. Test Pit Excavation and Percolation Tests

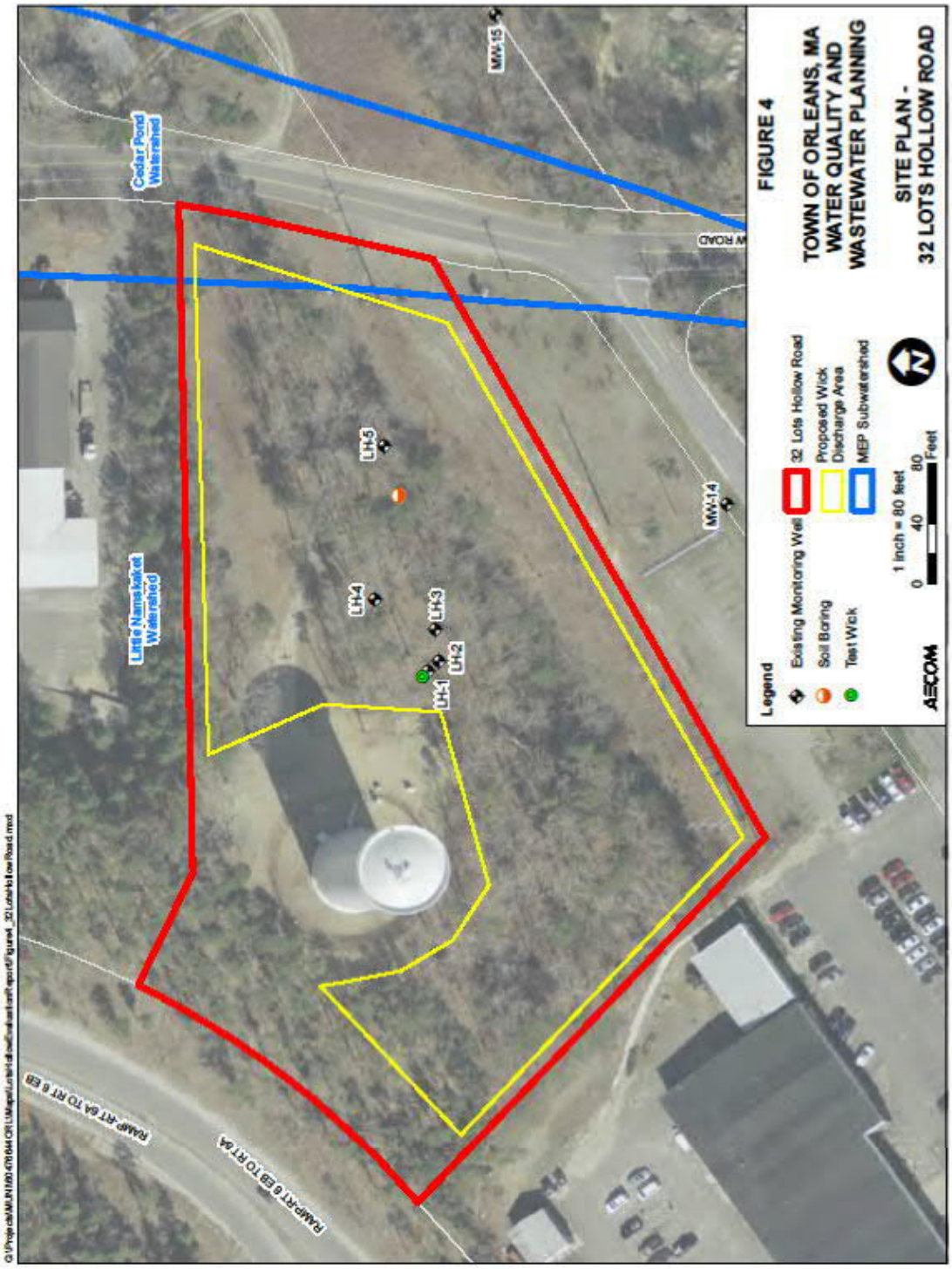
At the January 29, 2018 Site Visit, MassDEP stated that test pit excavations and Title 5 percolation tests were not required as part of the Hydrogeologic Evaluation. Test pit excavations generally expose soils to depths no greater than 15 feet. A permanent wick would likely not utilize the top 15 feet of the soil column for infiltration of the WWTF effluent. In addition, AECOM proposed a 30-day loading test was conducted at the site. The loading test is considered a better indicator of the site's capacity to discharge to groundwater through a wick.

3.3. Soil Boring and Monitoring Well Installation

3.3.1. 32 Lots Hollow

Five monitoring wells were installed by AECOM from December 2017 through February 2018, including LH-1, LH-2, LH-3, LH-4, and LH-5. Continuous sampling was conducted from the ground surface to depths of between 129 and 134 feet at locations LH-2, and LH-5 (Figure 4). Borings were installed with an AMS 9400 direct push rig, and soil core samples were collected for soil type characterization. Due to the depth to the water table, the direct push rig could not collect soil samples below 88 feet. A CME auger rig was used to collect split spoon samples below 88 feet. At all locations, an attempt to collect continuous soil samples to a minimum of 20 feet below the water table were made. Soils generally consisted of medium and fine sands, with occasional discontinuous lenses of silt or clay, no more than one to three inches thick.

Each monitoring well consisted of 10-foot sections of schedule 40 PVC riser pipe attached to 10-foot sections of 10-slot well screen. Natural sand pack was used between the well screen and the formation from the base of the well to approximately 2 feet above the well screen. The sand pack was then capped by approximately 2 feet of bentonite pellets and allowed to hydrate. Natural sand pack was allowed to collapse from above the bentonite to the surface.


FIGURE 4
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
SITE PLAN -
32 LOTS HOLLOW ROAD
Legend
Existing Monitoring Well
Soil Boring
Test Wick
32 Lots Hollow Road
Proposed Wick Discharge Area
MEP Subwatershed
1 inch = 80 feet
0
40
80
Feet
AECOM
Cedar Pond Watershed
Little Namskaket Watershed
MW-15
MW-14
LH-1
LH-2
LH-3
LH-4
LH-5
RAMP-RT 6A TO RT 6 EB
RAMP-RT 6 EB TO RT 6A

3.3.2. 43 Lots Hollow

A total of seven monitoring wells were installed by AECOM from January 2017 through August 2017, including MW-2 (236-246), MW-5 (140-150), MW-9, MW-15 (115-125), MW-15 (145-155), MW-16S (110-120), and MW-16D (140-150). Monitoring wells that were installed in a cluster of two or more wells include the depth of the screen interval (in parentheses) in the well name. Six monitoring wells were drilled with a truck-mounted CME auger rig. Continuous split spoon samples were collected at MW-5 (140-150). At all other augered locations, general soil descriptions were determined from drill cuttings removed from auger flights. MW-2 (236-246) was drilled with a truck-mounted sonic rig, which provided continuous sampling to a depth of approximately 246 feet below ground surface (bgs).

Each monitoring well consisted of 10-foot sections of schedule 40 PVC riser pipe attached to 10-foot sections of 10-slot well screen. Natural sand pack was used between the well and the formation from the base of the well to approximately 2 feet above the well screen. The sand pack was then capped by approximately 2 feet of bentonite pellets and allowed to hydrate. Natural sand pack was allowed to collapse from above the bentonite to the surface.

The monitoring wells were used to determine the water table elevation and collect water quality sample. All wells were surveyed for location and elevation relative to NAVD 1988. Water table elevations were used to estimate groundwater flow patterns. Copies of the boring logs with monitoring well details are provided in Appendix B. A summary of the well construction details is provided in Table 1.

3.4. Grain-Size Analysis

Soil samples were collected during the installation of the soil borings. Selected samples were submitted to a laboratory for grain size analysis. Copies of the laboratory grain-size analysis reports are provided in Appendix C. Results of the soils analysis are discussed in Section 4.2.1.

3.5. Pumping Tests

In July and August 2017, four 4-inch diameter PVC pumping wells were installed downgradient of the landfill at 43 Lots Hollow Road. Four pumping tests (one at each well) were then conducted to evaluate water quality and aquifer characteristics in the vicinity of the Orleans Landfill.

Each well was installed using a truck-mounted CME hollow-stem auger rig. Well PW-1S was installed to a depth of 125 feet below ground, with a 30 foot screen stretching from 95 to 125 feet below ground. Well PW-1D was installed to a depth of 160 feet below ground, with a 30 foot screen stretching from 130 to 160 feet below ground. Well PW-2S was installed to a depth of 130 feet below ground, with a 30 foot screen stretching from 100 to 130 feet below ground. Well PW-2D was installed to a depth of 154 feet below ground, with a 24 foot screen stretching from 130 to 154 feet below ground. The wells were installed in fine to medium sands. All wells were installed with 20-slot, continuously wound stainless steel well screen. Each well was developed with air until the water was clear. The deep and shallow wells at locations PW-1 and PW-2 were installed approximately 10 feet apart. The well locations are shown on Figure 5.

All wells were surveyed for location and elevation relative to NAVD 1988. The pumping and monitoring wells referenced in this section are shown on Figure 5. Well and groundwater elevation data are summarized in Table 1.

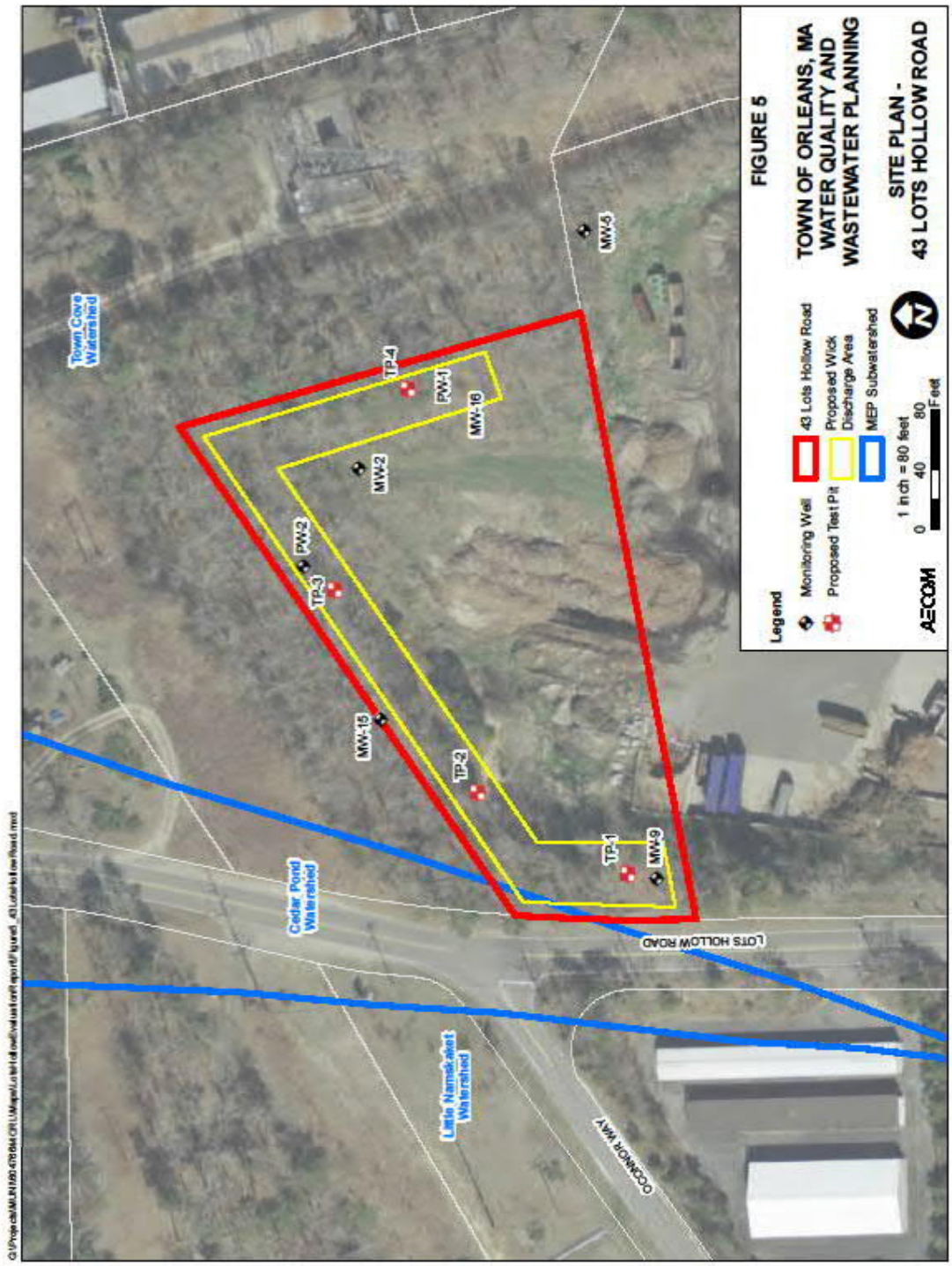

FIGURE 5
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
SITE PLAN -
43 LOTS HOLLOW ROAD
Legend
Monitoring Well
Proposed Test Pit
43 Lots Hollow Road
Proposed Wick
Discharge Area
MEP Subwatershed
1 inch = 80 feet
0
40
80
Feet
AECOM
Town Cove
Watershed
Cedar Pond
Watershed
Little Namskaket
Watershed
LOTS HOLLOW ROAD
COCONNOR WAY
MW-5
TP-4
PW-1
MW-16
MW-2
PW-2
TP-3
MW-15
TP-2
TP-1
MW-9

TABLE 1

SUMMARY OF WELL CONSTRUCTION DATA

Observation Well	Diameter (inches)	Borehole Depth	Depth of Screened Interval	Ground Elevation	Northing	Easting	Top of PVC Elevation (ft msl)	Depth to Water Table (4 25 17)	Groundwater Elevation (NAVD 88)
32 Lots Hollow St.									
LH-1	2.0	128	118 - 128	122.43	2747103.768	1065269.699	124.27	106.94	17.33
LH-2	2.0	129	119 - 129	121.78	2747096.171	1065276.156	123.81	106.45	17.36
LH-3	2.0	129	119 - 129	121.20	2747098.958	1065296.917	123.00	105.65	17.35
LH-4	2.0	124	114 - 124	122.30	2747139.563	1065317.244	123.79	106.45	17.34
LH-5	2.0	124	114 - 124	118.15	2747133.158	1065419.554	119.81	102.53	17.28
Test Wick	8.0	105	25 - 105	122.58	2747107.796	1065265.909	123.33	NA	NA
43 Lots Hollow St.									
MW-2S (84-94)	2.0	94	84 - 94	103.45*	2747083.146	1065868.116	101.4	86.33	15.07
MW-2D (124-134)	2.0	134	124 - 134	103.61*	2747082.25	1065873.604	101.6	87.28	14.32
MW-2 (140-150)	2.0	150	140 - 150	102.80	2747072.948	1065874.231	101.3	86.50	14.80
MW-2 (160-170)	2.0	170	160 - 170	102.90	2747074.158	1065866.368	101.42	86.6*	14.82
MW-5D	2.0	150	140 - 150	101.70	2746922.228	1066033.688	103.6	86.32	17.28
MW-9	2.0	102	92 - 102	105.50	2746873.731	1065600.504	107.32	89.85	17.47
MW-14	2.0	160	150 - 160	105.40	2746904.287	1065380.336	105.15	87.89	17.26
MW-15S	2.0	125	115 - 125	107.40	2747058.283	1065707.528	109.17	91.92	17.25
MW-15D	2.0	155	145 - 155	107.30	2747060.145	1065711.291	108.87	92.42	16.45
MW-16S	2.0	120	110 - 120	101.28	2746994.936	1065935.913	103.38	86.18	17.20
MW-16D	2.0	150	140 - 150	101.50	2746999.446	1065935.174	103.36	86.74	16.62
Pumping Well 1S	4.0	125	95 - 125	102.10	2747030	1065939	103.66	86.6*	17.06
Pumping Well 1D	4.0	160	130 - 160	102.20	2747049	1065933	104.29	87.9*	16.39
Pumping Well 2S	4.0	130	100 - 130	99.10	2747107	1065801	100.75	83.9*	16.85
Pumping Well 1D	4.0	160	130 - 160	99.30	2747110	1065809	101.11	85.4*	15.71
					Lat Long (NAD 27)				
USGS Wells									
OSW-22	2.0	52	52	39.00	41°47'26"	69°58'16"	39.1	34.64	4.46
BMW-22	1.25	52	49	50.45	41°46'30"	70°01'49"	50.4	28.36	22.08

Notes:
All depths in feet below ground level (bgl)
All elevations in feet (NAVD 88)
ft = feet
* - Estimated value

3.5.1. Pumping Wells PW-1S and PW-1D

The 4-inch diameter test well at PW-1S was pumped continuously for 24 hours from 2:00 pm on July 31, 2017 to 2:00 pm on August 1, 2017. The well was pumped to obtain water quality samples as well as drawdown data. During the test, the pumping rate was held constant at approximately 80 gallons per minute (gpm). Groundwater samples and water level data were collected prior to, during and at the conclusion of the pumping test.

The 4-inch diameter test well at PW-1D was pumped continuously for 24 hours from 10:00 am on August 3, 2017 to 10:00 am on August 4, 2017. During this time, the pumping rate was held constant at 80 gpm. Water level stabilization in each of the 4-inch diameter pumping wells was not achieved during either pumping test.

During the PW-1S pumping test water quality samples were collected after two, three, seven, eleven, fifteen, nineteen, twenty-two, and twenty-four hours of pumping. During the PW-1D pumping test water quality samples were collected after six, ten, fourteen, eighteen, twenty-one, and twenty-four hours of pumping. Samples were chilled on ice, picked up by courier, and transported under chain of custody for analysis at ESS Laboratory of Cranston, Rhode Island.

3.5.1.1. Pumping Test Operation – PW-1S

The 4-inch diameter test well at PW-1S was pumped at a constant rate of 80 gpm from 2:00 pm on July 31, 2017 to 2:00 pm on August 1, 2017. Prior to the startup of the pumping test, antecedent water levels were measured in selected observation wells. A copy of the pumping test data is provided in Appendix D.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2(84-94), MW-2(140-150), MW-5(130-140), MW-16S, PW-16D, and PW-1D during the 24-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers, and were used for aquifer analysis. Drawdown after 24 hours of pumping is shown in Table 2.

TABLE 2
DRAWDOWN PW-1S – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
MW-2 (84-94)	83	1.66
MW-2 (140-150)	77	0.30
MW-16S	33	0.74
PW-16D	29	0.72
PW-1D	23	0.23

At 2:00 pm on August 1, 2017 pumping was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery progressed as shown on Table 3.

TABLE 3
RECOVERY PW-1S – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
MW-2 (84-94)	83	43
MW-2 (140-150)	77	13
MW-16S	33	81
PW-16D	29	10
PW-1D	23	17

3.5.1.2. Pumping Test Operation – PW-1D

The 4-inch diameter test well at PW-1D was pumped at a constant rate of 80 gpm from 10:00 am on August 3, 2017 to 10:00 am on August 4, 2017. Prior to the startup of the pumping test, antecedent water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells PW-1S, MW-2(124-134), MW-2(140-150), MW-5(130-140), MW-16S, AND PW-1D during the 24-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers, and were used for aquifer analysis. Drawdown after 24 hours of pumping is shown in Table 4 below.

TABLE 4
DRAWDOWN PW-1D – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
PW-1D	0 (pumping well)	No Data
MW-2 (124-134)	66	0.81
MW-2 (140-150)	60	0.86
MW-5 (130-140)	27	0.15
MW-16S	44	0.14
PW-1S	23	0.11

At 10:00 am on August 4, 2017 pumping of the well was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery occurred as shown in Table 5.

TABLE 5
RECOVERY PW-1D – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
PW-1D	0 (pumping well)	N/A
MW-2 (124-134)	66	91
MW-2 (140-150)	60	87
MW-5 (130-140)	27	13
MW-16S	44	21
PW-1S	23	18

3.5.2. Pumping Wells PW-2S and PW-2D

Pumping well PW-2S was pumped continuously for 8 hours from 8:00 am to 4:00 pm on August 17, 2017 to obtain drawdown data and collect water quality samples. During this time, the pumping rate was held constant at 80 gallons per minute (gpm).

The 4-inch diameter test well at PW-2D was pumped continuously for 8 hours from 8:00 am to 4:00 pm on August 24, 2017 to collect water quality samples and obtain drawdown data. During this time, the pumping rate was held constant at 80 gpm. Water level stabilization in the 4-inch diameter pumping wells was not achieved during either pumping test.

During both the PW-2S and PW-2D pumping tests water quality sample were collected after two, four, and seven and a half hours of pumping. Samples were chilled on ice, picked up by courier, and transported under chain of custody for analysis at ESS Laboratory of Cranston, Rhode Island.

3.5.2.1. Pumping Test Operation – PW-2S

The 4-inch diameter test well at PW-2S was pumped at a constant rate of 80 gpm from 8:00 am to 4:00 pm on August 17, 2017. Prior to the startup of the pumping test, static water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2S, MW-15S, MW-15D, MW-2D, PW-2D, and PW-1S during the 8-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers, and were used for aquifer analysis. Drawdown after 8 hours of pumping is provided in Table 6.

TABLE 6
DRAWDOWN PW-2S – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
MW-2 (84-94)	83	1.66
MW-2 (140-150)	77	0.3
MW-5 (124-134)	159	NA
MW-16S	33	0.74
PW-16D	29	0.72
PW-1D	23	0.23

At 4:00 pm on August 17, 2017 pumping was discontinued and water levels in the above-mentioned observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery readings are summarized in Table 7.

TABLE 7
RECOVERY PW-2S – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
MW-2 (84-94)	83	43
MW-2 (140-150)	77	13
MW-5 (124-134)	159	NA
MW-16S	33	81
PW-16D	29	10
PW-1D	23	17

3.5.2.2. Pumping Test Operation – PW-2D

The 8-inch diameter test well at PW-2D was pumped at a constant rate of 80 gpm from 8:00 am to 4:00 pm on August 24, 2017. Prior to the startup of the constant-rate pumping test, antecedent water levels were measured in selected observation wells.

Water levels were measured manually at frequent and regular intervals at the 4-inch pumping well and in observation wells MW-2, MW-15D, PW-2S, PW-1D, and MW-16D during the 8-hour constant-rate pumping period. In the same observation wells, water levels were also measured using individual Onset HOBO electronic data loggers. Drawdown after 8 hours of pumping is summarized in Table 8.

TABLE 8
DRAWDOWN PW-2D – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Total Drawdown 24 hours (feet)
PW-2D	0 (pumping well)	12.11
MW-2	69	0.67
MW-15D	113	0.48
PW-2S	68	0.38
PW-1D	141	0.48
MW-16D	168	0.36

At 4:00 pm on August 24, 2017 pumping was discontinued and water levels in the observation wells were manually monitored for two hours. Electronic data loggers continued to collect recovery data for an additional 48 hours. Water-level recovery progressed as summarized in Table 9.

TABLE 9
RECOVERY PW-2D – 43 LOTS HOLLOW ROAD

Well ID	Distance from Pumping Well (feet)	Percent Recovery 2 hours (%)
PW-2D	0 (pumping well)	100
MW-2	69	96
MW-15D	113	104
PW-2S	68	92
PW-1D	141	94
MW-16D	168	94

3.5.3. Observation Wells

Water levels were measured before, during, and after each pumping test in the 4-inch diameter pumping wells and surrounding observation wells. Observation wells were also used to measure water-level drawdown and recovery due to pumping. Drawdown data was then used to compute aquifer hydraulic characteristics.

3.5.4. Precipitation

No precipitation was recorded during any of the pumping tests.

3.5.5. Pumping Test Discharge

Water was pumped from each of the 4-inch diameter pumping wells using an electrical submersible pumps driven by a single diesel-powered generator. Water was conveyed from the 4-inch diameter test well through temporary, 2-inch diameter hosing and discharged to the edge of the on-site stormwater retention basin located approximately 600 feet southeast of the pumping wells. The rate of flow from the 2-inch pumping wells was measured with an electronic flow meter on the discharge hose.

3.6. Slug Tests

On March 1, 2018, rising-head slug testing was performed at wells LH-1, LH-3, LH-5, MW-15S, MW-15D, and MW-16S. Wells were tested using a Midwest Geosciences “Pneumatic Hi-K Slug” slug testing apparatus. Each well was tested three times, to check for data reliability. Water levels were recorded with an In-Situ LevelTroll 700 pressure transducer. Water levels were allowed to stabilize after each test. Data was analyzed using Aqtesolv software. All slug tests were completed on the same day.

3.7. Water Quality

On August 8 and 9, 2017, water quality sampling was performed at 43 Lots Hollow Road and just upgradient of 32 Lots Hollow Road. Groundwater samples were collected from monitoring wells installed by AECOM: MW-2S, MW-2D, MW-2 (140-150), MW-2 (160-170), MW-9, MW-14, MW-15S, MW-15D, MW-16S, and MW-16D. Additionally, pumping wells PW-1S, PW-1D, PW-2S, and PW-2D were sampled during their respective pumping tests in July and August 2018. The samples were submitted for inorganic and organic analyses to ESS Laboratory of Cranston, Rhode Island, a Massachusetts certified analytical laboratory. In addition, water quality was tested in the field using an YSI water quality meter. Results of the water quality analysis are summarized in Section 4.3.

3.8. Test Wick and Loading Test – 32 Lots Hollow Road

On January 12 2018, AECOM submitted a Proposed Hydrogeologic Evaluation to MassDEP. The proposed scope of work proposed the design of the “test” wick, the installation of five monitoring wells, and a 30-day loading test. The 30-day loading test was conducted to evaluate whether the 32 Lots Hollow Road site could accommodate the groundwater discharge associated the discharge from the proposed WWTF.

3.8.1. Test Wick

One “test” wick was installed at 32 Lots Hollow Road, from February 6 through 7, 2018. A CME auger rig with 14-inch outside diameter (OD), 8-inch inside diameter (ID) augers was used to drill to a depth of 105 feet. A 2-inch diameter PVC well with 80 feet of screen was set inside the drilled hole and 3/8-inch diameter washed gravel was placed around the 2-inch well from a depth of 105 feet to ground surface. A plastic 6-foot diameter culvert pipe was set four feet into the ground as a protective cover for the test wick. PVC piping was inserted through the side of the culvert pipe. The piping was fitted with a firehose on the end outside the culvert pipe, and terminated inside a 90-degree bend which directed water downward into the wick. The “test” wick log is attached in Appendix B.

3.8.2. Loading Test Operation

Loading of the wick began at 12:00 pm on February 9, 2018 and was completed at 1:15 pm on March 14, 2018. Water discharged into the wick was supplied by the Town of Orleans water system, delivered via an on-site hydrant. Water use volume was determined by taking daily readings at a passive in-line meter installed at the hydrant. Loading rate was also calculated using the meter. Approximately 3.4 million gallons were discharged into the wick over the course of the 34 day loading test.

During the loading test, water levels were measured at on-site wells LH-1 through LH-5, and off-site wells MW-14, MW-9, MW-15S, CL-1, MW-2D, MW-16S, CL-2, MW-5, and CL-3. Water levels were measured twice daily at all wells for the first four days of the loading test, and thereafter once daily at the on-site wells and two to three times a week at the off-site wells. A copy of water level data recorded during the loading test is included in Appendix E.

USGS well BMW 22, located approximately 1.5 miles west of the 32 and 43 Lots Hollow Road site, was used to establish ambient water levels. Downloaded daily water levels are included in the water-level graphs on Figure 6. Monitoring well BMW-22 has been monitored since 1967, and is screened in a similar formation and hydrogeologic setting as the 32 Lots Hollow Road Site. A copy of the water level data at the ambient well is provided in Appendix F.

Precipitation data was provided by the Town of Orleans Water Department and is included in Appendix G along with detailed water level readings. Notable rain events of more than a half-inch were recorded on February 11 and 25, and March 2, 7, 12, and 14.

The loading test took place during a very wet winter. Over 8.82 inches of rain was recorded during the test. Groundwater levels at BMW-22 rose approximately 1.67 feet between the beginning and the conclusion of the loading test. Similar water table increases were noted across 32, and 43 Lots Hollow Road. Figure 6 shows cumulative rainfall and water level trends in all wells monitored during the loading test. Water levels rose across the entire study area during the loading test, including ambient well BMW 22, likely due to the 8.82 inches of rain received over the course of the loading test. The record high water level at BMW-22 was recorded on April 4, 2018, shortly after the conclusion of the loading test. Initial wick loading took place at 20 gpm, and was increased over the course of the test to a final loading rate of 88 gpm. Loading rates over time are summarized in Table 10. Wick mounding and analysis are discussed in Section 4.5.

TABLE 10
WICK LOADING TEST SUMMARY – 32 LOTS HOLLOW ROAD

Loading Rate		Loading Duration		Water-Level Rise, Feet								Efficiency	
gpm	gpd	Days at Rate	Total Days	LH-1 (5)*	LH-2 (15)*	LH-3 (30)*	LH-4 (60)*	LH-5 (125)*	MW-14 (250)*	MW-9 (415)*	Wick (0)*	Wick Efficiency (gpm/ft)	Wick Efficiency (gpd/ft)
20	28,800	1	1	0.03	0.03	0.02	0.03	0.03	-0.06	0.02	3.55	5.63	8,113
33	47,520	5	6	1.03	0.90	0.72	0.56	0.33	0.15	0.11	14.38	2.29	3,305
59	84,960	4	10	1.85	1.60	1.31	1.04	0.48	0.11	0.07	17.95	3.29	4,733
88	126,720	23	33	3.10	2.85	2.38	2.00	1.07	0.08	0.13	42.40	2.08	2,989
	Average											3.32	4,785

* Distance from test wick in feet.

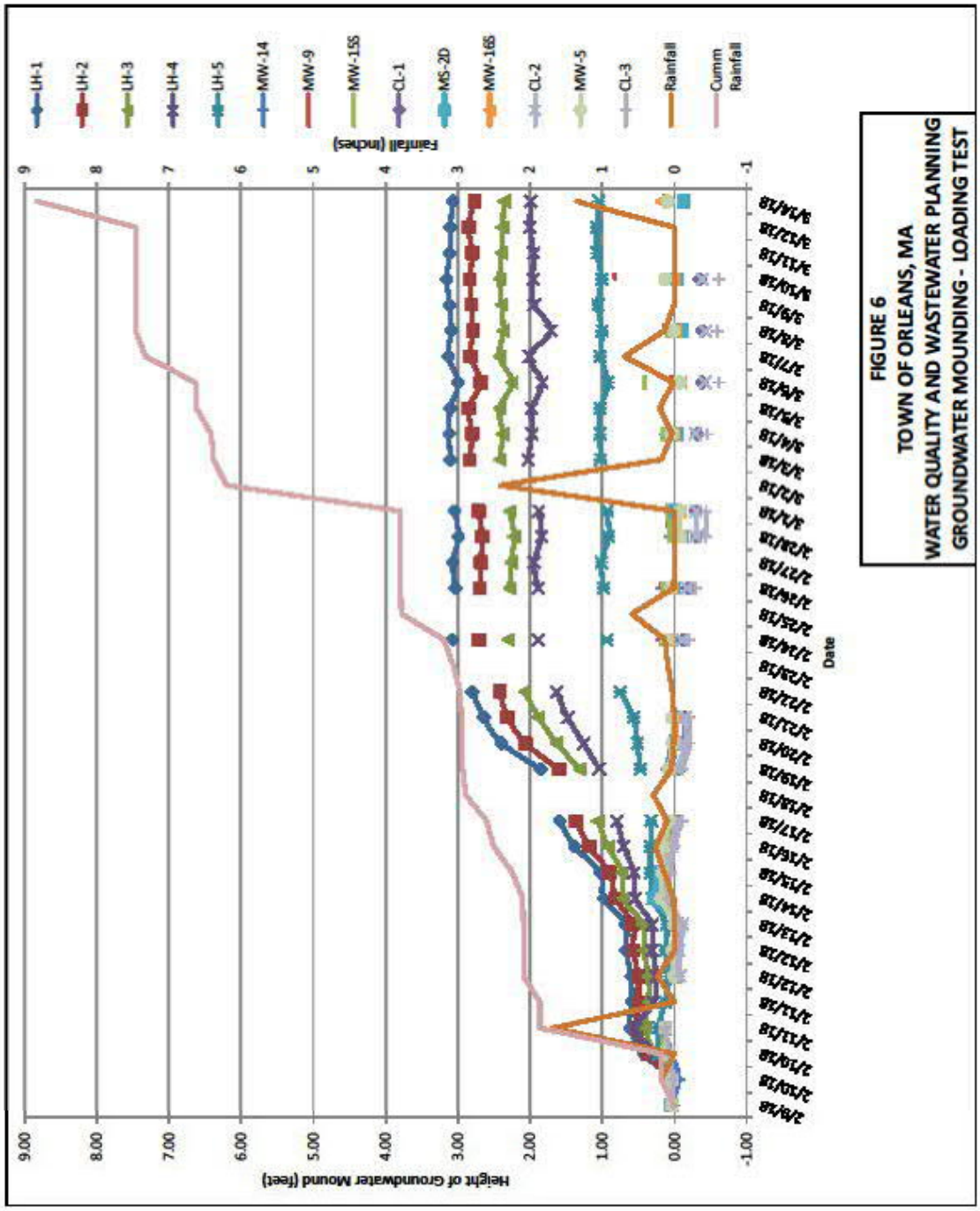


FIGURE 6
TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING
GROUNDWATER MOUNDING - LOADING TEST

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4. HYDROGEOLOGIC CONDITIONS AND DATA ANALYSIS

4.1. Geology, Groundwater Flow and Boundary Conditions

Orleans is underlain by glacially derived sediments deposited 15,000 or so years ago during the waning stages of continental glaciation. The sediments consist of outwash deposited from the melting of the Cape Cod Bay and South Channel Lobes of the glacier (Wordsworth and Wigglesworth, 1934). The Harwich Outwash Plain deposits were derived from the Cape Cod Bay Lobe, while the Nauset Heights and Eastham plain deposits were derived from the South Channel Lobe (Oldale et.al., 1971).

According to Koteff and Cotton (1962), coarse sand and gravel deposits (Harwich Outwash Plain Deposits) are underlain by coarse sands to clayey silts followed by compact basal till directly overlying bedrock. The relatively thin layer of basal till indicates that the soils were deposited as the result of a single glaciation. Previous seismic investigations in the Orleans beach area indicate the bedrock surface at about 400 feet below sea level (Oldale and Tuttle, 1964).

The 32 and 43 Lots Hollow Road parcel is underlain by Harwich Outwash Plan Deposits, as mapped by Oldale et.al (1971). According to Oldale, these deposits consist primarily of medium to very coarse sand and pebble to cobble gravel. In general, these deposits are fairly well sorted and very permeable. Till and boulders can be found shallow or overlying the deposits. Clayey silt can also be found in the deposits.

Due west and north of the site, lake deposits and lake bottom deposits from the Cape Cod Bay proglacial lake are mapped by Oldale et.al. (1971). The deposits due west of the site are described as being gravelly sand, pebble and gravel cobble gravel. Clayey silt and till can also be found. Deposits further to the northwest and north of the outwash deposits are described as being more gravelly and clayey silt.

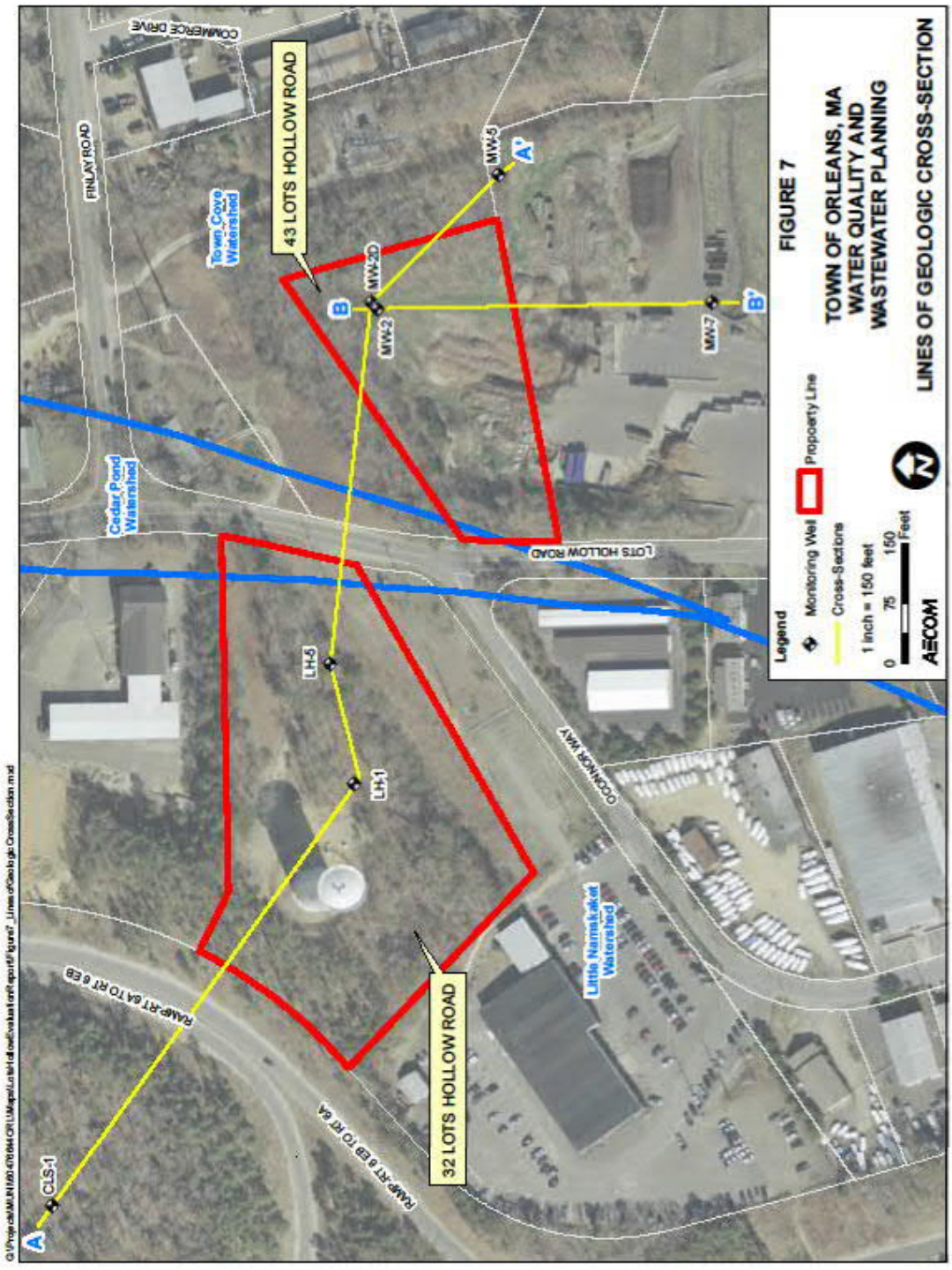
Geologic conditions found at the 32 and 43 Lots Hollow Road site through AECOM's field investigations are consistent with the deposits described above. In general, the soils encountered at 32 Lots Hollow were tan to brown fine-to-medium or medium sand with low percentages of silt to the full depths of the wells. Within this interval, occasional thin layers of silty sand, silt and silt with varying amounts of clay were encountered. These layers appeared to be discontinuous across the site and were no more than one to three inches thick.

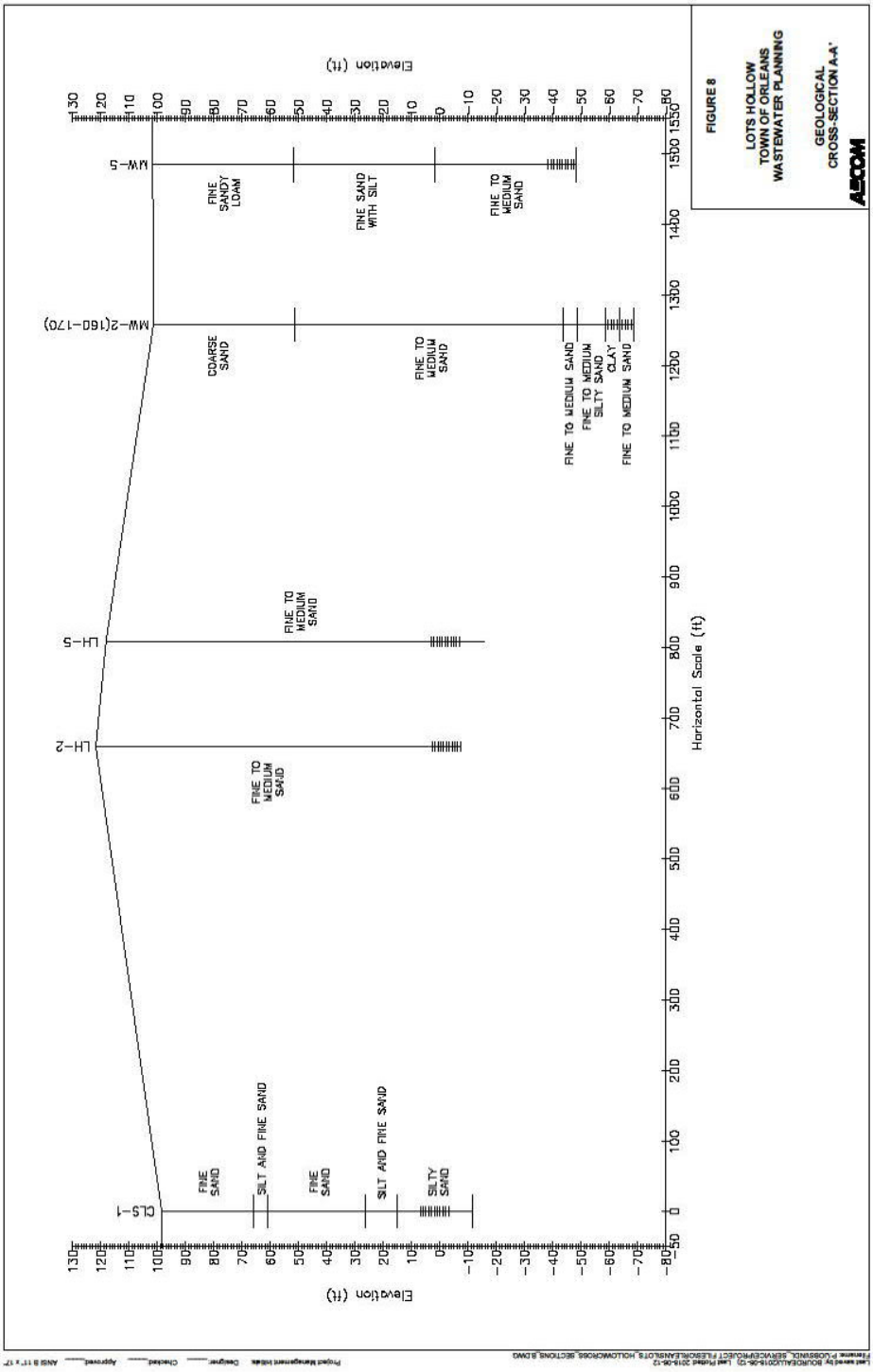
The soils at 43 Lots Hollow were tan to brown fine-to-medium or medium sand, with low percentages of silt. Within this interval, occasional thin layers of silty sand, silt and silt with varying amounts of clay were encountered. Brown to grey clay was encountered in some locations below a depth of approximately 154 feet. The clay appeared to be discontinuous across the site but in the area of PW-1D and MW-2(236-246) was thick.

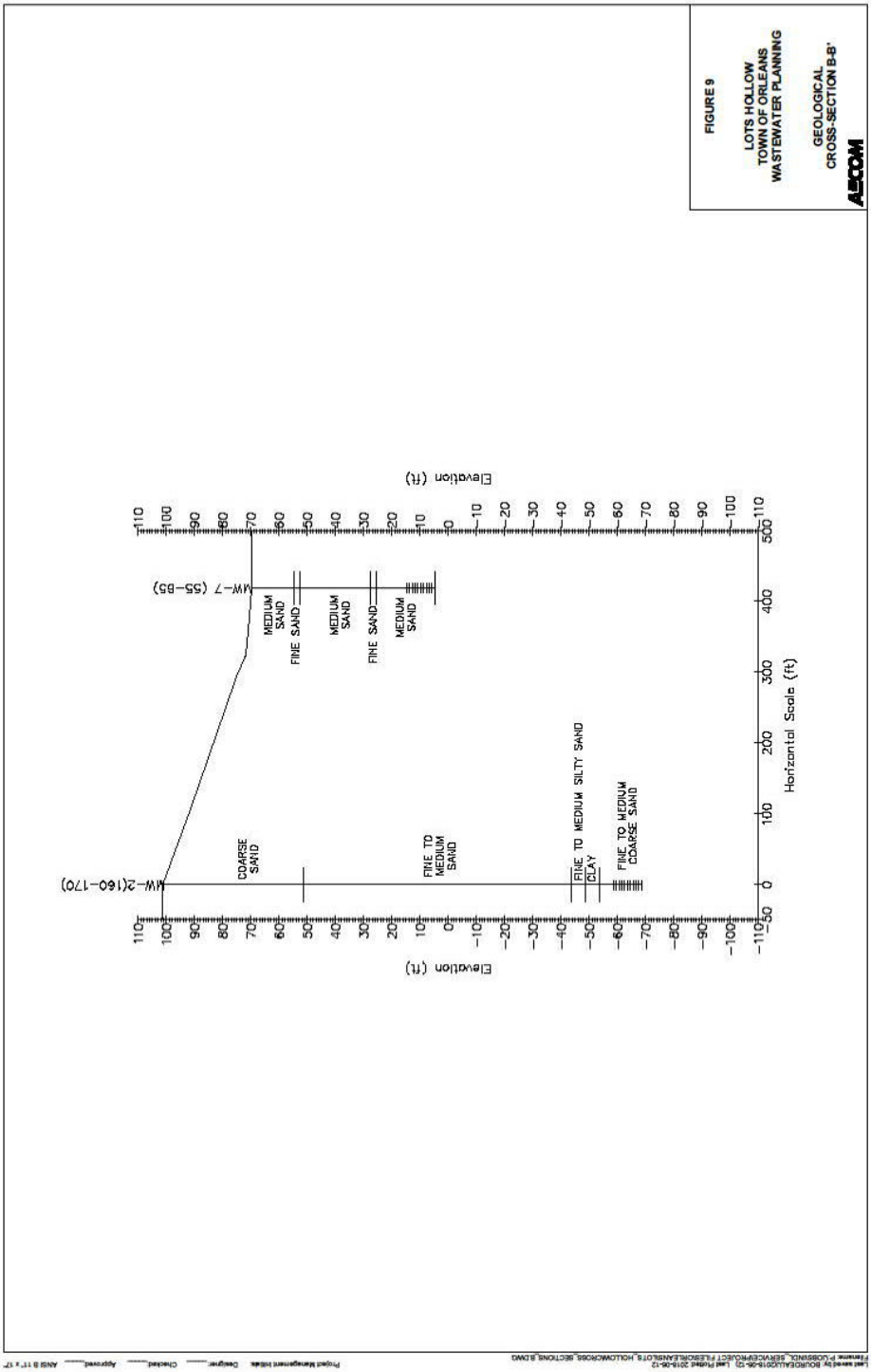
Groundwater was measured in the monitoring wells at a depth of approximately 88 to 108 feet below ground surface at the time of drilling.

The lines of geologic cross-section are shown on Figure 7. The geologic cross-sections A-A' and B-B' (Figure 8 and Figure 9, respectively) graphically depict geologic conditions locally and regionally. Well logs used to construct the geologic cross-sections are in Appendix B.

According to MEP water table maps, groundwater flows north northwesterly across the site toward the Namskaket and Little Namskaket Creeks (USGS, 2005). The drainage divide between the Namskaket and Little Namskaket Creek watersheds is located approximately 700 feet west of the 32 Lots Hollow site.


FIGURE 7
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
LINES OF GEOLOGIC CROSS-SECTION
Legend
Monitoring Well
Property Line
Cross-Sections
1 inch = 150 feet
0 75 150 Feet
AECOM
43 LOTS HOLLOW ROAD
32 LOTS HOLLOW ROAD
LOTS HOLLOW ROAD
COMMERCE DRIVE
FINLAY ROAD
O'CONNOR WAY
RAMP-RT 6A TO RT 6 EB
RAMP-RT 6 EB TO RT 6A
Town Cove Watershed
Cedar Pond Watershed
Little Namskaket Watershed
A
A'
B
B'
CLS-1
LH-1
LH-5
MW-2
MW-2C
MW-5
MW-7


FIGURE 8
LOTS HOLLOW
TOWN OF ORLEANS
WASTEWATER PLANNING
GEOLOGICAL
CROSS-SECTION A-A'
AECOM
Elevation (ft)
Horizontal Scale (ft)
MW-5
MW-2(160-170)
LH-5
LH-2
CLS-1
FINE SANDY LOAM
FINE SAND WITH SILT
FINE TO MEDIUM SAND
COARSE SAND
FINE TO MEDIUM SAND
FINE TO MEDIUM SAND
FINE TO MEDIUM SILTY SAND
CLAY
FINE TO MEDIUM SAND
FINE TO MEDIUM SAND
FINE TO MEDIUM SAND
FINE SAND
SILT AND FINE SAND
FINE SAND
SILT AND FINE SAND
SILTY SAND


FIGURE 9
LOTS HOLLOW
TOWN OF ORLEANS
WASTEWATER PLANNING
GEOLOGICAL
CROSS-SECTION B-B'
AECOM
Elevation (ft)
MW-7 (55-85)
MEDIUM SAND
FINE SAND
MEDIUM SAND
FINE SAND
MEDIUM SAND
MW-2(160-170)
COARSE SAND
FINE TO MEDIUM SAND
FINE TO MEDIUM SILTY SAND
CLAY
FINE TO MEDIUM COARSE SAND
Horizontal Scale (ft)
Elevation (ft)

4.2. Calculated Aquifer Hydraulic Conductivity

Aquifer conductivity values were estimated through laboratory grain-size analysis and slug tests. Details follow in this section.

4.2.1. Grain-Size Analysis

Samples collected from selected soil borings were submitted to a laboratory for grain-size analysis. In total, 12 soil samples were submitted: three samples each from soil borings at LH-2 and LH-5, and six samples from a soil boring at MW-2.

Hydraulic conductivity (K) and porosity (n) values for each of the 12 samples were estimated using several numerical methods including Kozeny-Carman (Carman, 1937), Shepards (1989), Hazen (1892), and Slitcher (1992).

At 32 Lots Hollow conductivity values ranged from 2 ft/day to 83 ft/day. The average value for the sampled described as “poorly graded sand” and “sand with silt” was 40 ft. Soils of this description make up the majority of the soils underlying the site. The average value for the thin (6-inches or less) and likely discontinuous layers of finer soils described as “silt with sand”, “silty sand”, and “silt samples” was 5 ft/day.

At 43 Lots Hollow conductivity values ranged from 2 ft/day to 150 ft/day. The average value for poorly graded sand and sand with silt samples, the majority of the soils underlying the site, was 58 ft/day. The average value for the thin layers of finer soils (silt with sand, silty sand, and silt samples) was 16 ft/day.

4.2.2. Pumping Test Analysis

Aquifer analysis was performed on both drawdown and recovery data from selected observation wells monitored during pumping tests PW-1S, PW-1D, PW-2S, and PW-2D, located at 43 Lots Hollow. Water level data was obtained with Onset HOBO pressure transducers and was analyzed using Aqtesolv software. Due to the distance between the pumping and monitoring wells, drawdown observed in the observation wells was generally a half foot or less, with only one well (MW-16S, monitoring during pumping of PW-1S) having drawdown exceeding a foot.

Due to this muted response, analysis of drawdown data did not yield meaningful values for transmissivity and conductivity. The small amount of drawdown observed during eight-hour and 24-hour tests, all at 80 gpm, is a very good indicator that the aquifer underlying 43 Lots Hollow is quite transmissive. As with 32 Lots Hollow, the high transmissivity of the aquifer underlying 43 Lots hollow will transmit a large quantity of water without significant drawdown or mounding. To obtain improved drawdown data in a future pumping test, observation wells would need to be located closer (within 30 feet) to the pumping wells, and screened in the same interval as the pumping well. Aqtesolv plots are included in Appendix I for reference.

4.2.3. Slug Test Analysis

At 32 Lots Hollow (LH-1, LH-3, and LH-5) average conductivity values ranged from 54 ft/day to 78 ft/day. These wells had not been previously developed, sampled, or otherwise pumped, and at each well the first slug test has a poor response, with a more robust, repeatable response occurring during the second and third tests. It is likely that the first slug test displaced some of the fines around the well screen, and as such, tests two and three are considered more representative of the conductivity of the formation around the well. All wells showed a very rapid response, with initial displacement and return to stabilized conditions occurring within 10-20 seconds.

At 43 Lots Hollow (MW-15S, MW-15D, MW-16S) conductivity values ranged from 29 ft/day to 86 ft/day. MW-15S and MW-16S exhibited similar behavior to the wells at 32 Lots Hollow Road, with rapid rise in head and stabilization within 10-20 seconds. MW-15D exhibited unusual behavior, in which head rapidly rose, and then oscillated several time before stabilizing. The data is a poor fit for analysis with type curves, and meaningful conductivity values were not able to be obtained.

4.3. Groundwater

The study area, which includes 32 and 43 Lots Hollow Road sites is located at the groundwater divide between the Little Namskaket Creek, Cedar Pond (Rock Harbor River), and Town Cove Watersheds (Figure 1). Locally, groundwater flows north. Water levels measured on May 29, 2018 from 11 observation wells were used to estimate the groundwater flow direction across the study area. Each well was surveyed relative to NAVD 1988. Using the survey data, the water levels obtained at each location were converted to elevation in NAVD 1988. A summary of groundwater elevation data is provided in Table 1.

The static groundwater elevations were plotted on a map and approximated contours of the potentiometric surface were drawn. The resulting contours are shown on Figure 10. Contours were inferred between monitoring well locations. Based on the contours, groundwater flow across the site is 0.0032 ft/ft to the north-northeast. The hydraulic gradient was calculated between the 16 and 17 foot contour at a distance of approximately 316 ft. The groundwater contours are shown on Figure 10.

In general, elevated nitrate levels above the Massachusetts drinking water standard are detected across the site. Higher nitrate is observed in the more shallow wells, with deeper wells having relatively low or non-detect nitrate levels. Chloride levels and sulfide levels are elevated above the Massachusetts guidance values. Results of the field and laboratory testing are summarized in Table 11. Copies of the laboratory reports are provided in Appendix K.

4.4. Surface Water

The nearest surface water body is the upper reaches of Namskaket Creek, approximately 1,800 feet to the west. However, groundwater flows is north northwest towards Little Namskaket Creek, Rock Harbor, Boat Meadow River, and Town Cove which are approximately 4,900, 6,300, 8,300 and 5,600 feet respectively from the discharge.

4.5. Loading Test Analysis

As described in Section 3.8.1, a 2-inch diameter PVC well was installed inside the 12-inch diameter test wick to monitor water levels during the loading test. Water levels in the test wick were digitally monitored throughout the loading test using an Onset Hobo data logger. Manual water level readings were also collected periodically. Table 10 summarizes the loading rates, high water levels (within the wick and monitoring wells) noted during each loading rate, and the number of days of loading at each rate.

To evaluate the test wick's performance, each loading rate was divided by the mound height (in feet). The resulting value is referred to as the wick efficiency and is expressed as gallon per day of discharge per foot of mounding within the test wick (gpd/ft)..

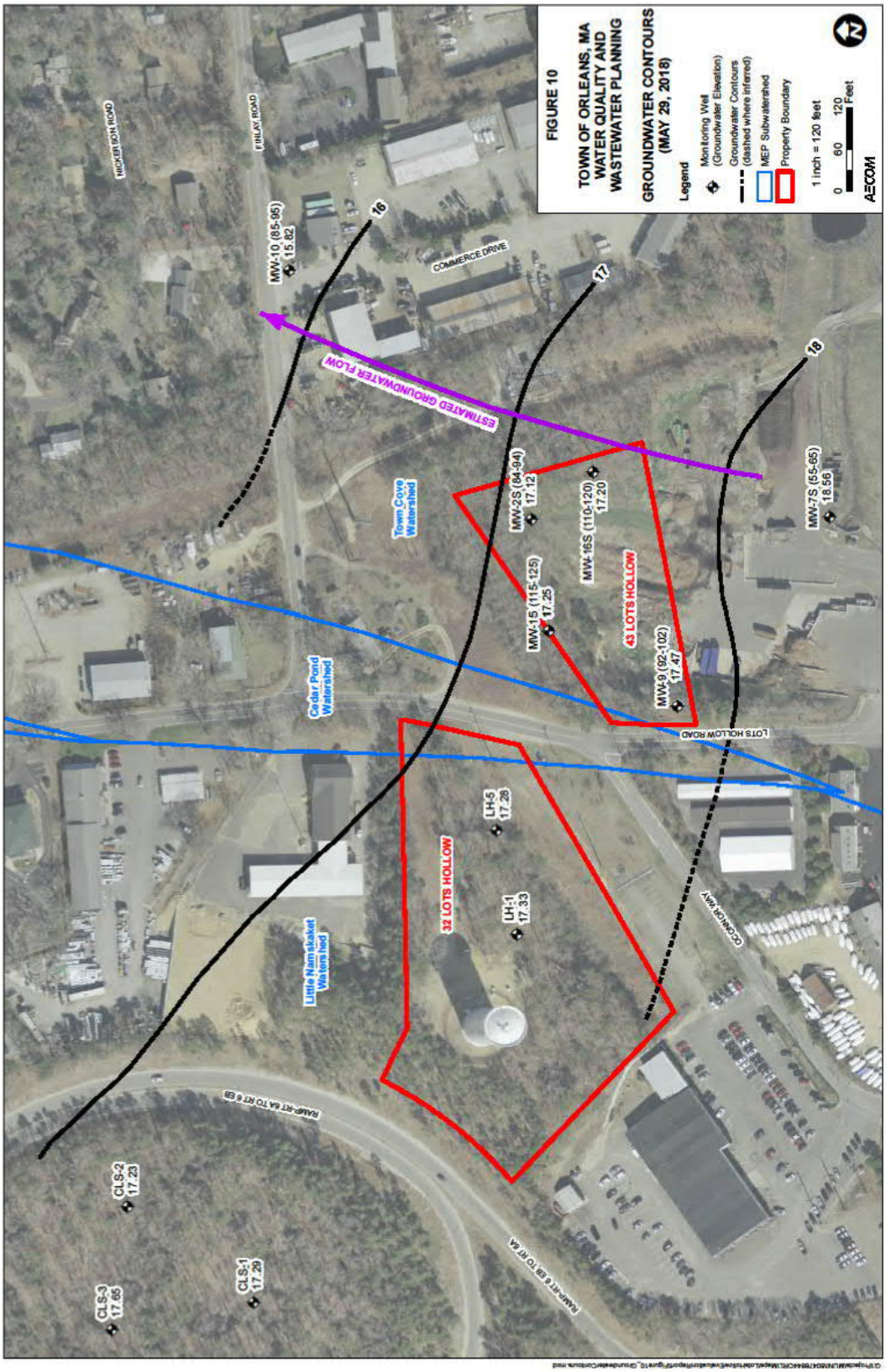

FIGURE 10
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
GROUNDWATER CONTOURS
(MAY 29, 2018)
Legend
Monitoring Well
(Groundwater Elevation)
Groundwater Contours
(dashed where inferred)
MEP Subwatershed
Property Boundary
1 inch = 120 feet
0
60
120
Feet
AECOM
HIGHLAND ROAD
FINLAY ROAD
COMMERCE DRIVE
LOTS HOLLOW ROAD
COUNCIL WAY
RAMP-RT 6A TO RT 6 EB
RAMP-RT 6 EB TO RT 6A
ESTIMATED GROUNDWATER FLOW
16
17
18
MW-10 (85-95)
15.82
MW-2S (84-94)
17.12
MW-16S (110-120)
17.20
MW-15 (115-125)
17.25
MW-9 (92-102)
17.47
MW-7S (55-65)
18.56
LH-5
17.28
LH-1
17.33
CLS-2
17.23
CLS-1
17.29
CLS-3
17.65
32 LOTS HOLLOW
43 LOTS HOLLOW
Town Cove Watershed
Cedar Pond Watershed
Little Namskaket Watershed

TABLE 11
SUMMARY OF WATER-QUALITY RESULTS

Parameter	Units	MRL	Drinking Water Standard[1]	MW-2S	MW-2D(124-134)	MW-2(140-150)	MW-2(160-170)	MW-5	MW-9	MW-14	MW-15S	MW-15D	MW-16S	MW-16D	PW-1S	PW-1D	PW-2S	PW-2D
Sample Date:				2/6/2017	2/6/2017	2/6/2017	3/26/2017	3/27/2017	2/8/2017	8/14/2017	8/4/2017	8/4/2017	8/8/2017	8/8/2017	8/1/2017	8/4/2017	8/17/2017	8/24/2017
Field Results:																		
pH	S.U.	NA	6.5-8.5[2]	4.8	6.0	6.0	5.7	6.1	5.0	1.9	4.1	4.5	6.1	6.3	4.9	5.6	6.1	6.0
Specific Conductance	µmho/cm	0	NE	751	800.0	637.0	620.0	377	297	223	365	430	581	503	689	616	465	544
Turbidity	NTU	0.25	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Temperature	°C	0.01	NE	16.0	15.5	15.2	14.4	14.6	15.9	14.8	14.5	14.8	15.6	15.5	15.0	14.8	16.6	18.4
ORP	mV	0.1	NE	129.8	54.5	65.1	57.5	196.9	139.1	672.7	517.9	554.9	7.5	40.8	-87.1	59.2	137.0	103.8
Dissolved Oxygen	mg/L	2.5	NE	1.6	0.1	0.1	0.0	0.17	7.4	3.3	5.3	7.8	0.2	0.2	0.55	0.3	0.88	0.21
Laboratory Results:																		
Chloride	mg/L	3.0	2502	88.8	97.7	49.0	43.6	39.6	65.5	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate-N	mg/L	0.03	10	18.8	0.208	0.03	<0.03	<0.03	20.20	8.44	2.20	0.46	<0.03	<0.03	2.12	<0.03	0.17	0.19
Nitrite-N	mg/L	0.01	1	0.0	0.014	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Ammonia as N	mg/L	0.50	NE	0.14	11.5	11.9	13.7	9.34	0.34	0.16	0.55	0.80	10.30	7.39	7.18	11.1	4.89	4.96
VOCs	µg/L	0.5	0.5															
1,4-dioxane	µg/L	0.25	0.3[3]	<0.25	1.84	2.05	NS	<0.25	<0.25	NS	NS	NS	NS	NS	NS	NS	NS	NS

NA = not applicable
ND = not detected
NE = not established
NTU = Nephelometeric turbidity units
µg/L = microgram per liter
S.U. = standard units

[1]Mass. Maximum Contaminant Level
[2]Mass. Secondary Maximum Contaminant Level
[3]Mass. DEP Office Research and Standards Goal
mg/L = milligram per liter
µmho/cm = micromho per centimeter
MRL = Minimum Reporting Limit

The mound height within the wick is dependent on several factors: the loading rate, the permeability of the artificial-gravel pack within the wick, the permeability of the surrounding soils, and the amount of surface area between the wick and the surrounding soils per foot of wick. In the full scale wick, the permeability of the artificial-gravel pack will be great enough that the pack's impact on mounding is negligible. This will leave the loading rate, the permeability of the surrounding soils and the surface area of the wick as the primary factors in wick mounding. A larger diameter wick, which creates more surface area with the formation per foot of wick, will also produce less mounding.

Using the test wick as an example, at a discharge rate of 88 gpm (126,000 gpd) a wick efficiency of 3,000 gpd/ft of wick mounding was calculated (Table 12). Using this wick efficiency and assuming that the formation above the wick mound has the same permeability, the 1-foot diameter test wick could potentially discharge 300,000 gpd or 3,000 gpd/ft times 100 feet.

TABLE 12
SUMMARY OF ESTIMATED WICK MOUNDING

	Estimated Wick Mound					
	1-foot Diameter Test Wick Wick Surface Area (314 sqft/ft)			3-foot Diameter Final Wick Wick Surface Area (942 sqft/ft)		
Discharge Rate	Wick Efficiency (gpd/ft)	Mound Height	Depth to Mound*	Wick Efficiency (gpd/ft)	Mound Height	Depth to Mound*
150,000	3,000	50	50	9,000	17	83
200,000	3,000	67	33	9,000	22	78
350,000	3,000	117	-17	9,000	39	61
400,000	3,000	133	-33	9,000	44	56
450,000	3,000	150	-50	9,000	50	50
500,000	3,000	167	-67	9,000	56	44

To estimate wick mounding and the potential discharge capacity of a larger diameter wick, the efficiency of the test wick (3,000 gpd/ft) was multiplied by the increase in the surface area per foot between the test and full scale wick. For example, if the wick diameter is increased from 1 to 3 feet, the surface area between the wick and surrounding formation would increase by a factor of 3. Assuming the same formation and infiltration rate, the wick efficiency should also increase by a factor of three. Using the test wick location as an example, the wick efficiency of the 1-foot diameter test wick was 3,000 gpd/ft, if a 3-foot diameter wick were installed at the same location the wick efficiency should increase to approximately 9,000 gpd. Therefore, a 100-foot deep 3-foot diameter wick installed at the same location as the test wick, should discharge approximately 500,000 gpd with a wick mound height of approximately 56 feet (Table 12). This would place the top of the mound approximately 44 feet below the ground surface at the test wick site.

Based on soil borings drilled at 32 and 43 Lots Hollow Road, the subsurface soils appear to be fairly uniform across the sites. However, variations in soil conditions and in the assumptions outlined above will lead to wick efficiencies differing at each wick location. To account for these variations, a borehole will be installed at each proposed wick location to collect soil samples. Each full scale wick will also be load tested once installed to verify the wick efficiency and discharge capacity of each wick.

The anticipated discharge from the WWTF from the Downtown Area is not expected to exceed 150,000 gpd initially and 250,000 gpd at build-out. The WWTF flow could increase to 350,000 gpd if flow from the Meetinghouse Pond Area is tied into the WWTF. . Mound heights at these flows at wick efficiency of 9,000 gpd/ft are summarized in Table 12.

At this time, it is anticipated that three to four wicks will initially be installed at 32 Lots Hollow Road. Each wick will be designed to discharge between 350,000 and 500,000 gpd at a minimum. Once installed, each wick will be load tested using potable water to evaluate wick mounding, wick efficiency, and wick capacity. Details of the wick design and testing will be submitted with the WWTF design.

5. GROUNDWATER MODELING EVALUATION

Groundwater modeling was performed by AECOM as a part of the evaluation of disposal options to provide feedback on potential designs; this feedback can then be used to help make design decisions. Specifically for this project, numerical groundwater flow modeling was used by AECOM to predict changes in groundwater elevations and flow directions based on the volume of discharge.

More specifically, the purpose of the groundwater modeling was to: (1) evaluate the potential impacts of the groundwater discharge on ambient groundwater flow and water levels; (2) evaluate where the effluent originating from the discharge at 32 and 43 Lots Hollow Road site discharges; and (3) estimate the nitrate load discharging to each watershed.

5.1. Modeling Method

A regional three-dimensional groundwater flow model of the Monomoy Lens was developed by the USGS as a tool for understanding the groundwater flow system and water budget in this region of Cape Cod (USGS, 2004). This regional groundwater flow model formed the basis of the model modified by AECOM for the purpose of performing groundwater discharge simulations.

MODFLOW was used by AECOM for this analysis (MacDonald and Harbaugh, 1988). The three-dimensional groundwater flow model was coupled with a particle tracking model called MODPATH (Pollack, 2004) in order to illustrate the potential movement of groundwater over time. Both of these models were used on the GMS platform, Version 10.3.

5.2. Conceptual Model of the Aquifer System

A conceptual site model (CSM) of a groundwater flow system is a representation of how an aquifer functions based on available data. Geologic maps and cross-sections, groundwater flow maps, and the generalized water balance (the volume of water entering and leaving the aquifer) are common elements of a conceptual aquifer model. AECOM's understanding of how the regional groundwater flow system functions is based on the geological and hydrological data presented in Sections 3.0 and 4.0; additionally the CSM is based on the work done and reported on by the USGS (2004).

The CSM for hydrogeology and groundwater flow in the Monomoy Lens is well documented in the USGS (2004) report. Overall, the CSM documented in the USGS (2004) report is the same as is used for AECOM's modeling effort. However, AECOM's investigation of the 32 and 43 Lots Hollow Road site completed in March 2018 was used to compare actual site conditions to the USGS's CSM. AECOM's work included new wells and hydraulic testing of the aquifer to estimate the aquifer's hydraulic conductivity (K) in the vicinity of the Lots Hollow Sites. These results of the investigation and data analysis are discussed in Sections 3.0 and 4.0 of this document.

In general, the aquifer in the Town of Orleans is a water table aquifer composed of sand with varying amounts of silt and trace amounts of gravel. The bottom of the aquifer is assumed to coincide with the bottom of the numerical model, around 350 feet elevation below sea level.

According to the USGS's CSM, water enters the aquifer system primarily in the form of rainfall recharge. Groundwater then leaves the aquifer system through surface water features, such as lakes, streams, wetlands, estuaries, marshes, and the ocean. A small portion is withdrawn from the aquifer through public and private water-supply wells.

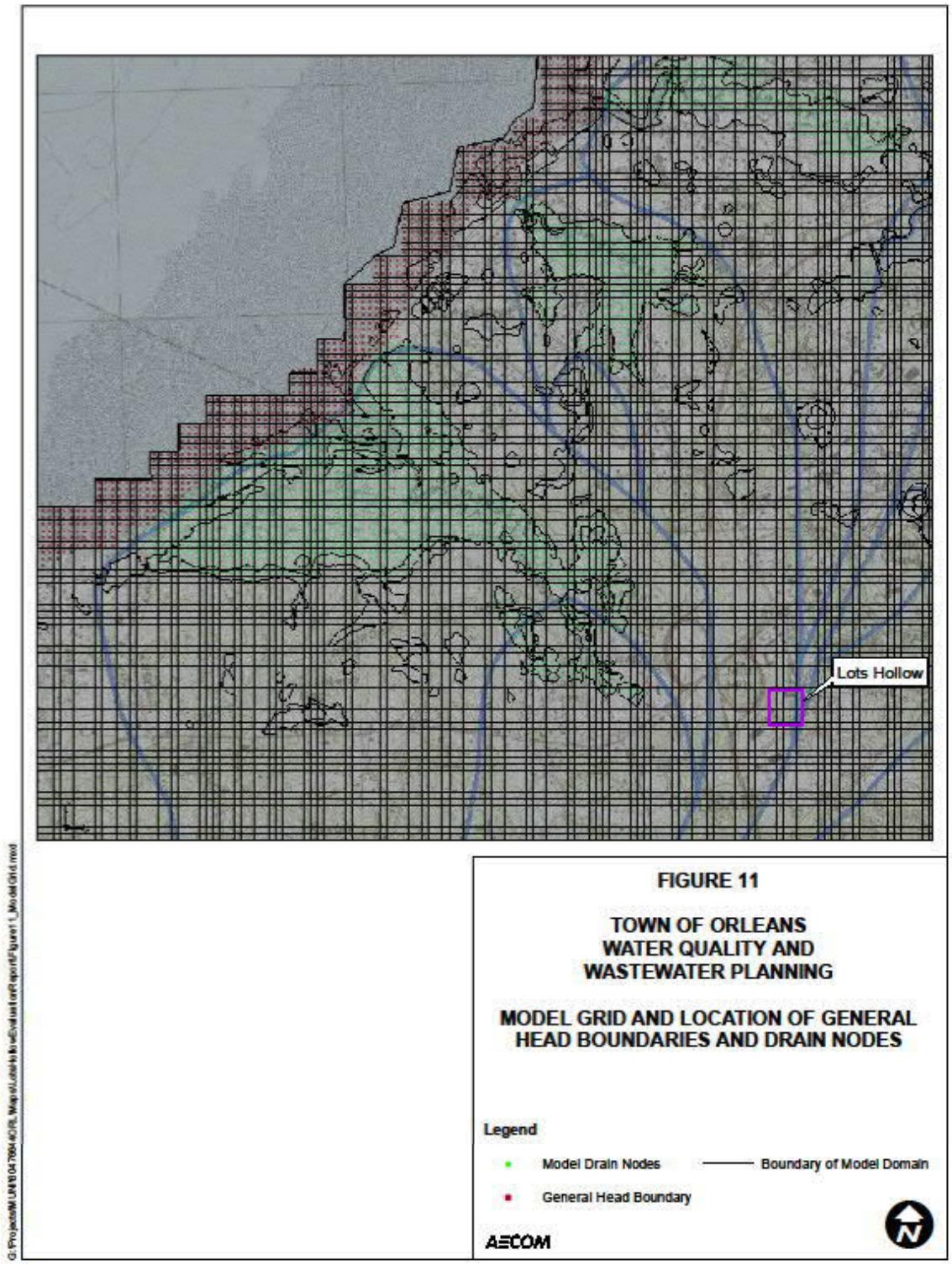
5.3. Model Design and Updates

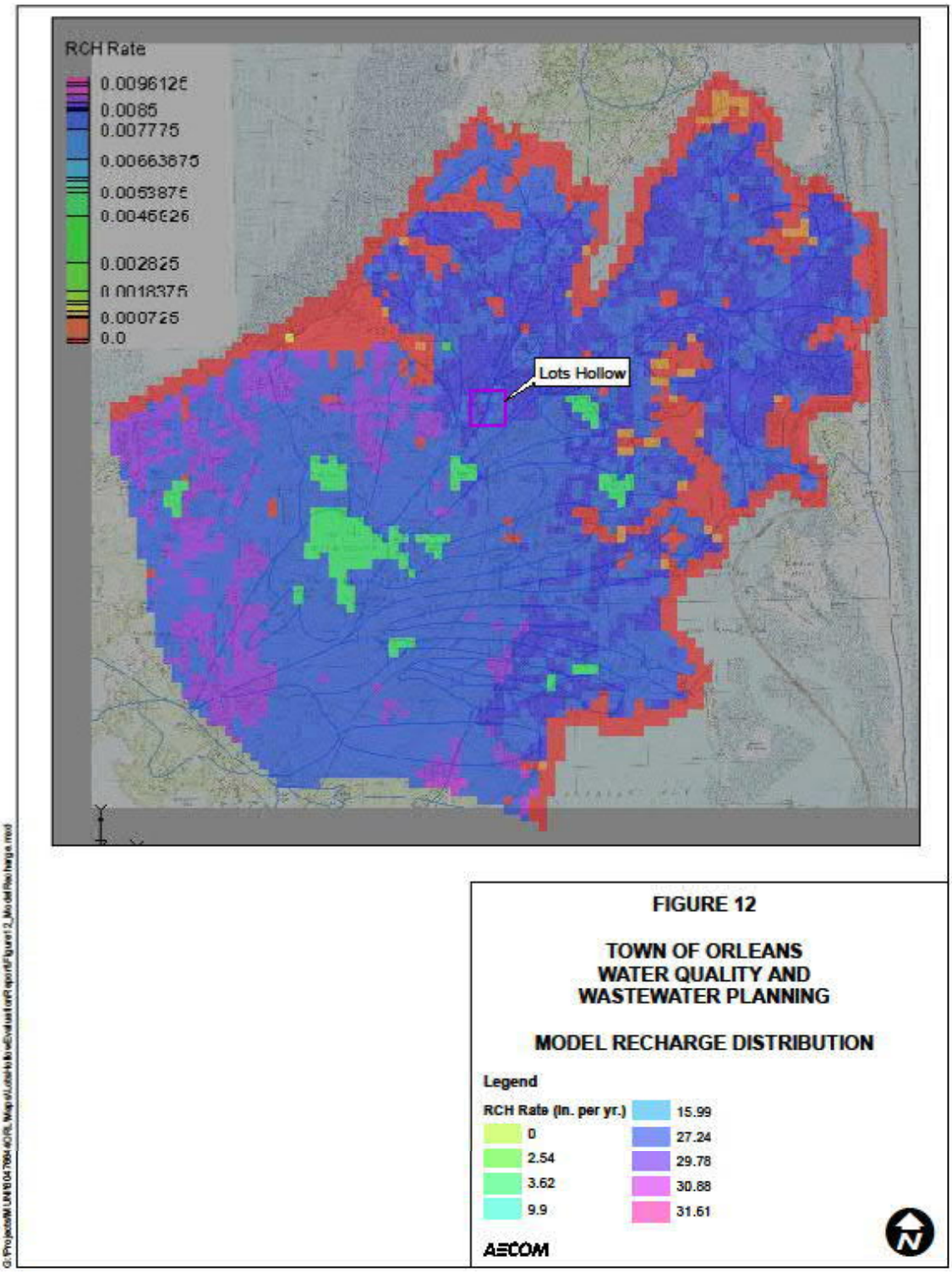
AECOM's numerical groundwater flow modeling was completed using the USGS numerical groundwater flow model of the Monomoy Lens as a basis. This model is documented in "Simulated Water Sources and Effects of Pumping on Surface and Ground Water, Sagamore and Monomoy Flow Lenses, Cape Cod, Massachusetts" (USGS, 2005). Modeling files were received from the USGS and were imported by AECOM into the GMS 10.3 platform. GMS is a pre- and post-processor for MODFLOW-2000 that facilitates data input, and depiction and interpretation of output.

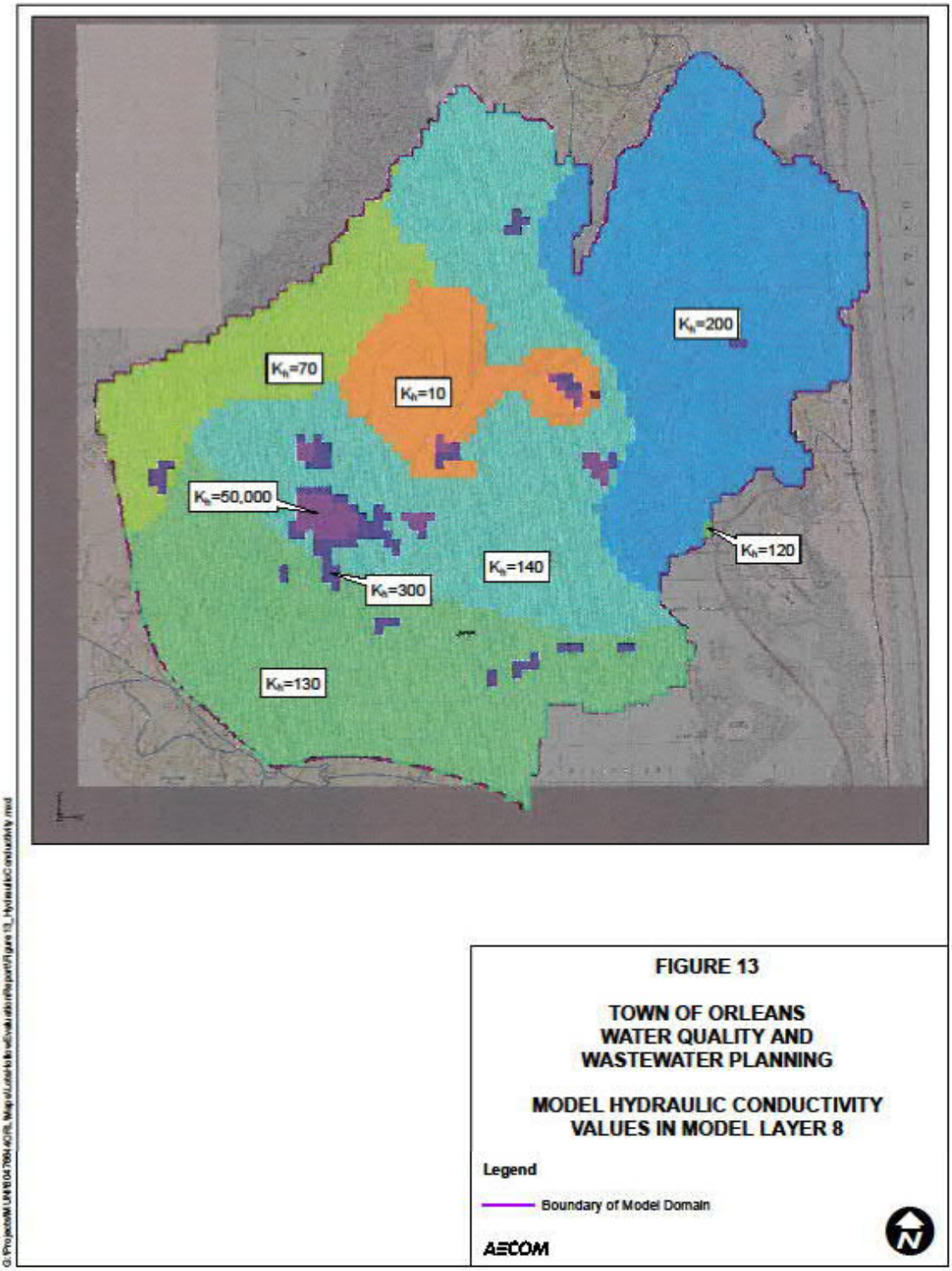
5.3.1. Model design

The model prepared by the USGS, and modified by AECOM, is structured as follows:

- The USGS model runs as a steady-state model, which incorporates long-term average conditions.
- The USGS model domain includes the entire Monomoy Lens. A map of this domain is included in Appendix 1 (USGS, 2004) Figure 1-1A. The model domain updated by AECOM is bounded primarily by surface water features (streams, marshes, inlets, estuaries, and ocean). AECOM adjusted the southwestern limit of the model domain from the full regional model; a no-flow boundary was assigned there to coincide with the groundwater divide.
- The original USGS model and AECOM modified model are both 20 layers. In this area of the Monomoy Lens, the groundwater table is low enough such that many of the upper layers go dry. The uppermost layer that is wet over the entire model domain is layer 8. The bottom of the USGS and ACEOM's updated model domain ranges from approximately 300 to 400 feet below sea level. With the exception of the lowest model layer, the model layers are uniform thickness across the model domain, see Appendix 1 (USGS, 2004) Figure 1-1B.
- AECOM changed the model grid from 400 by 400 foot nodes to 100 by 100 foot nodes across the model domain (Figure 11). Drain nodes and boundary conditions are shown on Figure 11.
- USGS assigned rainfall recharge using a variable array for the model domain. The USGS rainfall recharge rate ranges from 0 to 33.7 in/year, with a model wide average of 22.9 inches per year. Lesser rates or zero rainfall recharge rates were assigned to wetlands, open water, and/or oceans. Figure 12 shows rainfall recharge distribution across the model domain. In the calibration process, AECOM increased the recharge, discussed in section 5.3.2.
- USGS simulated surface-water features in a variety of ways:
    - Streams, wetlands, marshes, estuaries and other drainages features were simulated using the drain (DRN) package.
    - The Atlantic Ocean and Cape Cod Bay were simulated with a general head boundary (GHB).
    - Lakes were simulated with horizontal flow boundaries (HFB) and high hydraulic conductivity.
    - The USGS model included using the stream (STR) package for some surface water drainages, but when the model domain was made smaller, those features were outside of the new domain and therefore excluded. For that reason, AECOM's model does not use the stream package.
- Hydraulic conductivity values used in the USGS model range from 10 ft/day for sandy silts to 300 ft/day for sand and gravel deposits. The distributions of horizontal hydraulic conductivity values (k_h) in ft/day for layer 8 (the layer representing the water table aquifer) in the USGS model are shown in Figure 13. High hydraulic conductivities (50,000 ft/day) were used for lakes. AECOM's recent site investigations completed at the 32 and 43 Lots Hollow Road site indicated that the soils were fine- to coarse-grained sediments, resulting in hydraulic conductivity values ranging from 2 to 86 ft/day for the sandy soils underlying the site. The average conductivity also decreased with depth. These values were consistent with the USGS model for these areas; therefore AECOM made no changes to horizontal or vertical hydraulic conductivity in the model.


Lots Hollow
FIGURE 11
TOWN OF ORLEANS
WATER QUALITY AND
WASTEWATER PLANNING
MODEL GRID AND LOCATION OF GENERAL
HEAD BOUNDARIES AND DRAIN NODES
Legend
Model Drain Nodes
Boundary of Model Domain
General Head Boundary
AECOM
N


RCH Rate
0.0096125
0.0085
0.007775
0.00663875
0.0053875
0.0046625
0.002825
0.0018375
0.000725
0.0
Lots Hollow
FIGURE 12
TOWN OF ORLEANS
WATER QUALITY AND
WASTEWATER PLANNING
MODEL RECHARGE DISTRIBUTION
Legend
RCH Rate (In. per yr.)
0
2.54
3.62
9.9
15.99
27.24
29.78
30.88
31.61
AECOM
N


K_h=70
K_h=10
K_h=200
K_h=50,000
K_h=140
K_h=120
K_h=300
K_h=130
FIGURE 13
TOWN OF ORLEANS
WATER QUALITY AND
WASTEWATER PLANNING
MODEL HYDRAULIC CONDUCTIVITY
VALUES IN MODEL LAYER 8
Legend
Boundary of Model Domain
AECOM
N

- The original USGS model included groundwater extraction consistent with water usage from production wells using the well (WEL) package. Extraction rates are summarized in Appendix 1 of the USGS (2004) report Table 1-3. Most simulations of discharge were completed with 2002 pumping rates. One simulation used USGS estimated future 2020 pumping rates (Walter & Whealan, 2005) to evaluate changes to flow originating from the landfill given future water usage. AECOM simulated wastewater discharge by adding recharge in select cells within the model at the locations of 32 and 43 Lots Hollow Road. This is discussed in the Model Simulations section below.

5.3.2. AECOM Model Updates

AECOM made a number of changes to the model to meet model objectives. They are as follows:

- AECOM converted the solver package to the PCG2 package from the LMG (Link Multi-Grid) package based on a recommendation from the USGS in the model documentation that accompanied the model files ("…due to licensing restrictions, the USGS is no longer able to publicly distribute the Algebraic Multi-Grid (AMG) solver, on which the Link-AMG (LMG) Package relies. There are two possible solutions: 1) use a standard solver publicly available from USGS, such as SIP or PCG2 or 2) obtain the AMG/LMG solver from Fraunhofer-Institute for Algorithms and Scientific Computing (SCAI).").
- AECOM converted the USGS model grid from 400 by 400-foot to 100 by 100-foot cells over the entire domain. This was completed to provide better resolution on the model inputs (i.e., discharge areas) and outputs.
- In refining the grid, AECOM updated some model features:
  - Drain cell conductances were adjusted to reflect the new dimensions of the grid cells.
  - General Head boundary conductances were adjusted to reflect the new dimensions of the grid cells.
  - Horizontal flow barrier segments were added as needed to surround the ponds/lakes in the model domain.

Figure 11 shows a portion of AECOM's updated model grid, general head boundaries and drain nodes. The distribution of recharge is shown in Figure 12. The hydraulic conductivity values used by the USGS and AECOM are shown in Figure 13.

After AECOM made the changes above, the model was verified to be a good representation of the original USGS model in the following ways:

- A comparison of steady-state groundwater elevations was made in select cells/areas to demonstrate that AECOM's new version of the model-predicted groundwater elevations similar to those predicted by the USGS model. Generally, the differences were less than 0.5 feet and lower in many instances. There are a handful of cells where AECOM model predictions exceed USGS-model predictions by more than 1 foot, but these are far from the areas of interest and so should not impact model predictions.
- A comparison of groundwater flow directions was made using particle tracking. Particles were seeded in select areas to verify that AECOM's groundwater flow paths and divides are similar to those mapped by the USGS. In general, the AECOM version of the model was the same or similar to the particle tracking under ambient conditions from the USGS version of the model.

- AECOM made a comparison of mass balance generated by the two models. Specifically, recharge, well, general head boundary, drain boundary volumes were compared to verify that the water balances were the same or similar to the USGS model. Table 13 summarizes the comparison. The percent differences on the water budget components are very small; most differences can be attributed, in part, to the regridding and resulting changes to conductances of the drain and general head boundaries.
- The change in the model solver (from LMG to PCG2) may also have resulted in a slightly different solution.

In summary, AECOM made a number of changes to the original USGS model domain and structure to better meet the project objectives. Despite the changes, the AECOM model replicated the USGS output adequately; differences can be explained and are not expected to impact model predictions. Overall, AECOM considers this model a good tool to complete a preliminary evaluation of effluent disposal scenarios at the Lots Hollow Road Sites.

5.4. Model Calibration

USGS calibrated the full Monomoy Lens model and this process is described in Appendix 1 of the USGS report (2004). In accordance with our scope, AECOM verified that the calibration was maintained after the domain and grid were updated as discussed above. In summary:

- Simulated groundwater elevations from the USGS model compared favorably to the simulated groundwater elevations generated in the AECOM model.
- Simulated groundwater flow paths from the USGS model compared favorably to the simulated groundwater flow paths generated in the AECOM model.
- The water budget of the USGS model (for the area of interest) compared favorably with the water budget for the AECOM model.

Regionally, the updated model was able to reproduce the results from the original USGS model very closely.

On April 25, 2017, AECOM measured groundwater levels at numerous wells in Orleans. An estimate of high groundwater levels across the town was made based on the differences between the high and April 2017 groundwater levels at OSW-22. In this case, the historic high groundwater level at OSW-22 was 1.8 feet higher than that observed by AECOM on April 25, 2017. The estimated high groundwater elevations (measured plus adjusted based on OSW-22) were higher than the simulated groundwater levels at the target locations predicted by the model. Therefore, the model was further calibrated to better simulate the estimated high water table conditions.

To achieve this, numerous model runs were performed, varying several parameters, including rainfall recharge, hydraulic conductivity values, the drain node elevation, and the drain node elevations. As a result of the calibration process, the following changes were made:

- Rainfall recharge was increased by 25 percent across the model grid. Overall, the USGS average rainfall recharge rate of 22.9 inches was increased to 28.6 inches;
- The location of the Namskaket Creek drain nodes, were changed to better simulate the geometry of the marsh boundary; and,
- The Namskaket Creek drain node elevations and conductivity values were made consistent.

At the conclusion of the calibration process, the model was considered a good tool for conducting predictive simulations. The AECOM simulated groundwater elevations compared favorably to our estimates for high groundwater elevation conditions. The results of the calibrated steady-state model output for Layer 8 are shown in Figure 14. Table 14 summarizes the estimated high water table and model-simulated elevations

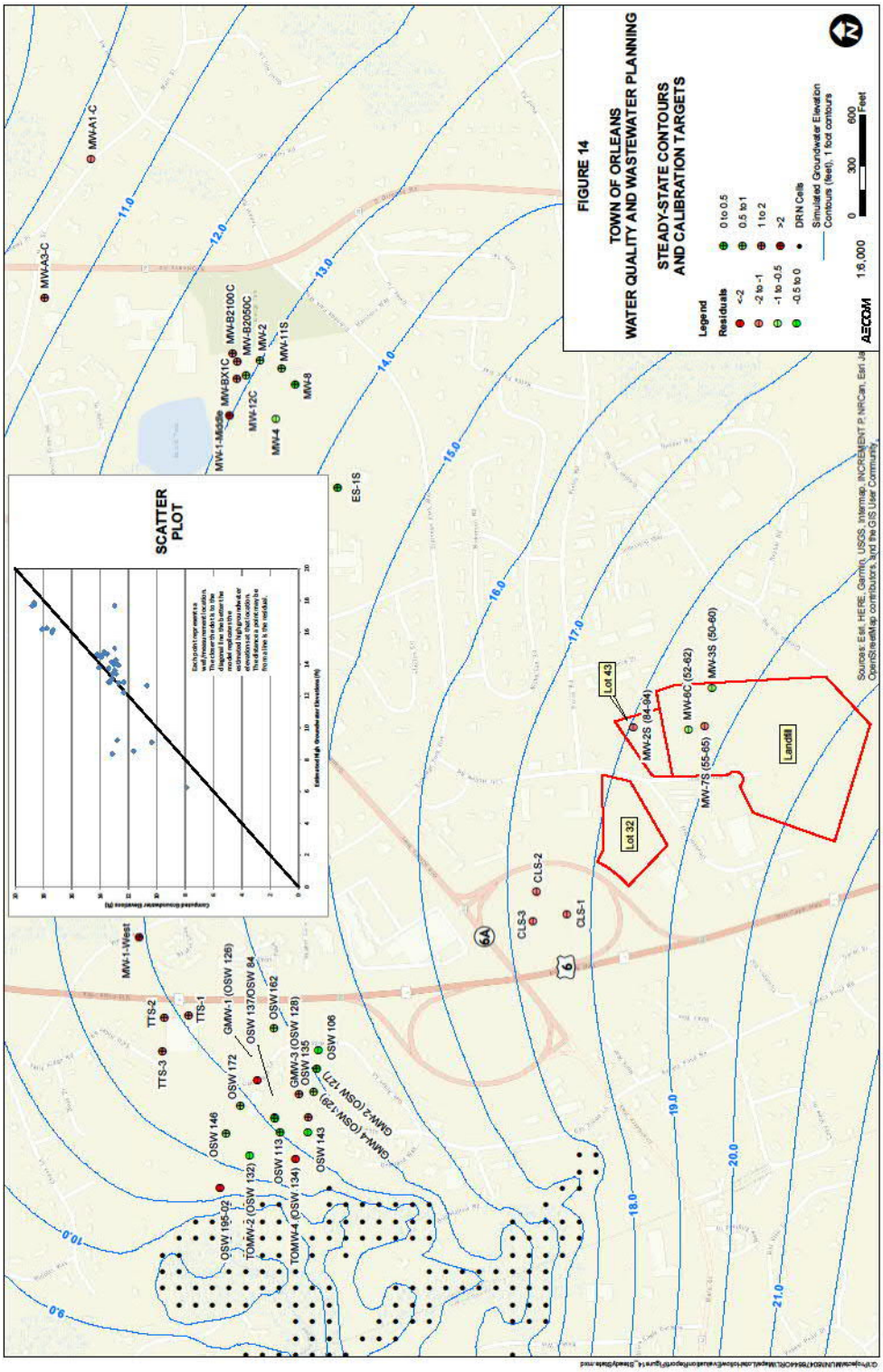

FIGURE 14
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
STEADY-STATE CONTOURS
AND CALIBRATION TARGETS
Legend
Residuals
<-2
-2 to -1
-1 to -0.5
-0.5 to 0
0 to 0.5
0.5 to 1
1 to 2
>2
DRN Cells
Simulated Groundwater Elevation Contours (feet), 1 foot contours
0
300
600
Feet
1:6,000
AECOM
SCATTER PLOT
Lot 43
Lot 32
Landfill
MW-A1-C
MW-A3-C
MW-B2100C
MW-B2050C
MW-2
MW-11S
MW-8
MW-12C
MW-4
MW-1-West
ES-1S
MW-2S (84-94)
MW-6C (52-62)
MW-3S (50-60)
MW-7S (55-65)
CLS-1
CLS-2
CLS-3
TTS-1
TTS-2
TTS-3
GMW-1 (OSW 126)
OSW 137/OSW 84
OSW 162
GMW-3 (OSW 128)
OSW 135
OSW 106
GMW-4 (OSW 129)
GMW-2 (OSW 127)
OSW 172
OSW 146
OSW 113
OSW 143
OSW 195-02
TOMW-2 (OSW 132)
TOMW-4 (OSW 134)
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0

TABLE 13
COMPARISON OF MASS BALANCE

	Subset of USGS Regional Model[1]	AECOM (Updated) Model[2]	Difference	Percent Difference from Original
IN (ft^3/day):				
CONSTANT HEAD	0.00	0.00		
WELLS	0.00	0.00		
DRAINS	0.00	0.00		
GENERAL HEAD	0.00	0.00		
RECHARGE	3,899,661.85	3,906,112.50	-6,450.64	-0.17%
STREAM LEAKAGE	0.00	NA		
Zone 1 to zone 2	192,978.09	0.00	192,978.09	
Total IN	4,092,639.94	3,906,112.50	186,527.44	
OUT (ft^3/day):				
CONSTANT HEAD	0.00	0.00		
WELLS	239,703.00	239,703.00	0.00	
DRAINS	2,137,289.64	2,152,853.94	-15,564.31	-0.73%
GENERAL HEAD	1,472,953.97	1,513,555.55	-40,601.58	-2.76%
RECHARGE	0.00	0.00		
STREAM LEAKAGE	0.00	NA		

Notes:
1 - Using Zonebudget, calculated based on approximate same domain as the Updated Model
2 - Using Zonebudget.

TABLE 14
COMPARISON OF HIGH WATER TABLE CONDITIONS

Location	Estimated High Groundwater Elevations (feet)	Simulated Groundwater Elevations (feet)	Residuals (feet)	Average Residual
MW-2S (84-94)-Shallow	16.21	18.10	-1.89	-0.007
MW-3S (50-60)-Shallow	17.72	18.68	-0.96	
MW-6C (52-62) -Shallow	17.87	18.66	-0.79	
MW-7S (55-65)-Shallow	17.68	18.81	-1.13	
MW-1-Middle-Shallow	15.01	12.99	2.02	
MW-2-Shallow	13.99	12.99	1.00	
MW-4-Shallow	12.84	13.41	-0.57	
MW-8-Shallow	13.74	13.41	0.33	
MW-11S-Shallow	14.13	13.21	0.92	
MW-12C-Shallow	13.6	12.95	0.65	
MW-B2050C-Shallow	14.02	12.81	1.21	
MW-BX1C-Shallow	14.24	12.89	1.35	
MW-B2100C-Shallow	13.98	12.73	1.25	
ES-1S-Shallow	14.62	14.24	0.38	
CLS-1-Shallow	16.27	17.76	-1.49	
CLS-2-Shallow	16.02	17.40	-1.38	
CLS-3-Shallow	16.13	17.34	-1.21	
TTS-1-Shallow	14.14	13.13	1.01	
TTS-2-Shallow	14.26	12.91	1.35	
TTS-3-Shallow	13.94	12.69	1.25	
OSW 137-Shallow	13.08	13.19	-0.11	
OSW 84-	13.41	13.08	0.33	
OSW 135-Shallow	14.64	13.49	1.15	
OSW 146-Shallow	12.85	12.34	0.51	
OSW 143-Shallow	12.85	13.31	-0.46	
OSW 162-Shallow	8.35	13.31	-4.96	
OSW 172-Shallow	13.4	12.89	0.51	
OSW 113-Shallow	12.82	12.7	0.12	
OSW 106-Shallow	13.8	14.09	-0.29	
OSW 195-02-Shallow	8.53	11.63	-3.10	
OSW 132-Shallow	12.22	12.36	-0.14	
OSW 134-Shallow	9.23	12.79	-3.56	
GMW-2 (OSW 127)-Shallow	14.56	14.12	0.44	
GMW-3 (OSW 128)-Shallow	14.77	13.72	1.05	
GMW-4 (OSW 129)-Shallow	14.45	13.91	0.54	
OSW 126-Shallow	14.52	13.88	0.64	
MW-1-West-Shallow	17.67	12.98	4.69	
MW-A1-C-Shallow	9.09	10.35	-1.26	
MW-A3-C-Shallow	12.64	10.70	1.94	
OSW-22-Shallow	6.26	7.88	-1.62	

The model generated contours shown on Figure 14 represent high water table conditions across the area of interest. The monitoring well locations shown on the figure are where water level data was collected on April 25, 2017 and high water table conditions were estimated. The residuals (Table 14) are the calculated difference between the model-simulated and the estimated high water table condition at each monitoring well location.

Well locations where the model-predicted water-table elevation is within 0.5 feet of the estimated high water-table elevation is indicated by dark green. Lighter green symbols indicate that the simulated water-table elevation is between 0.5 and on 1.0 feet of the calculated high water-table. Light and dark red symbols represent locations where the residual is between 1.0 and 2.0 feet, and is greater than 2.0 feet, respectively. Monitoring-well symbols with a "+" are locations where the model-simulated water-table elevation is higher than the estimate water-table conditions for that site. A negative ("-") indicate that the simulated water-table is lower than the estimated high water-table elevation.

Also shown on Figure 14 is a graph plotting model-simulated and estimated high water-table elevations at each monitoring well location. The residual at each location is the distance between the diagonal line and point plotted. The closer the point to the diagonal line, the lower the residual and the closer the model is simulating the AECOM estimated high water-table conditions. As indicated by the scatter plot, the points are fairly evenly distributed above and below the diagonal line and the residuals are also relatively close to the line. Both indicate that the model is reasonably well calibrated to the estimated high water-table conditions.

5.5. Predictive Simulations

AECOM's calibrated groundwater flow model was used to simulate fifteen discharge scenarios to predict groundwater mounding and the flow of groundwater (particle tracking) from the discharge sites. The 32 Lots Hollow Road site has been designated the primary discharge area by the Town while 43 Lots Hollow Road has been designated a reserve discharge area. Model scenarios were performed simulating a groundwater discharge at 32 Lots Hollow Road only, 43 Lots Hollow Road only, and the with the discharge taking place over both sites. Five discharge volumes (50,000 gpd, 150,000 gpd, 250,000 gpd, 350,000 gpd, and 500,000 gpd) were simulated and compared to a zero discharge scenario (base case).

5.5.1. 32 Lots Hollow Road Groundwater Discharge

Figure 15 compares the no-discharge (base case) simulated groundwater flow contours and particle pathlines with five scenarios at increasing groundwater discharge rates at 32 Lots Hollow Road. A close inspection of groundwater contours indicates that as the discharge rate increases a mound develops. The estimated maximum mound height under 32 Lots Hollow Road at various flow rates is provided in Table 15. The mound heights are all sufficiently low so as to keep the required separation between the groundwater mound under high water-table conditions and the land surface of the groundwater discharge.

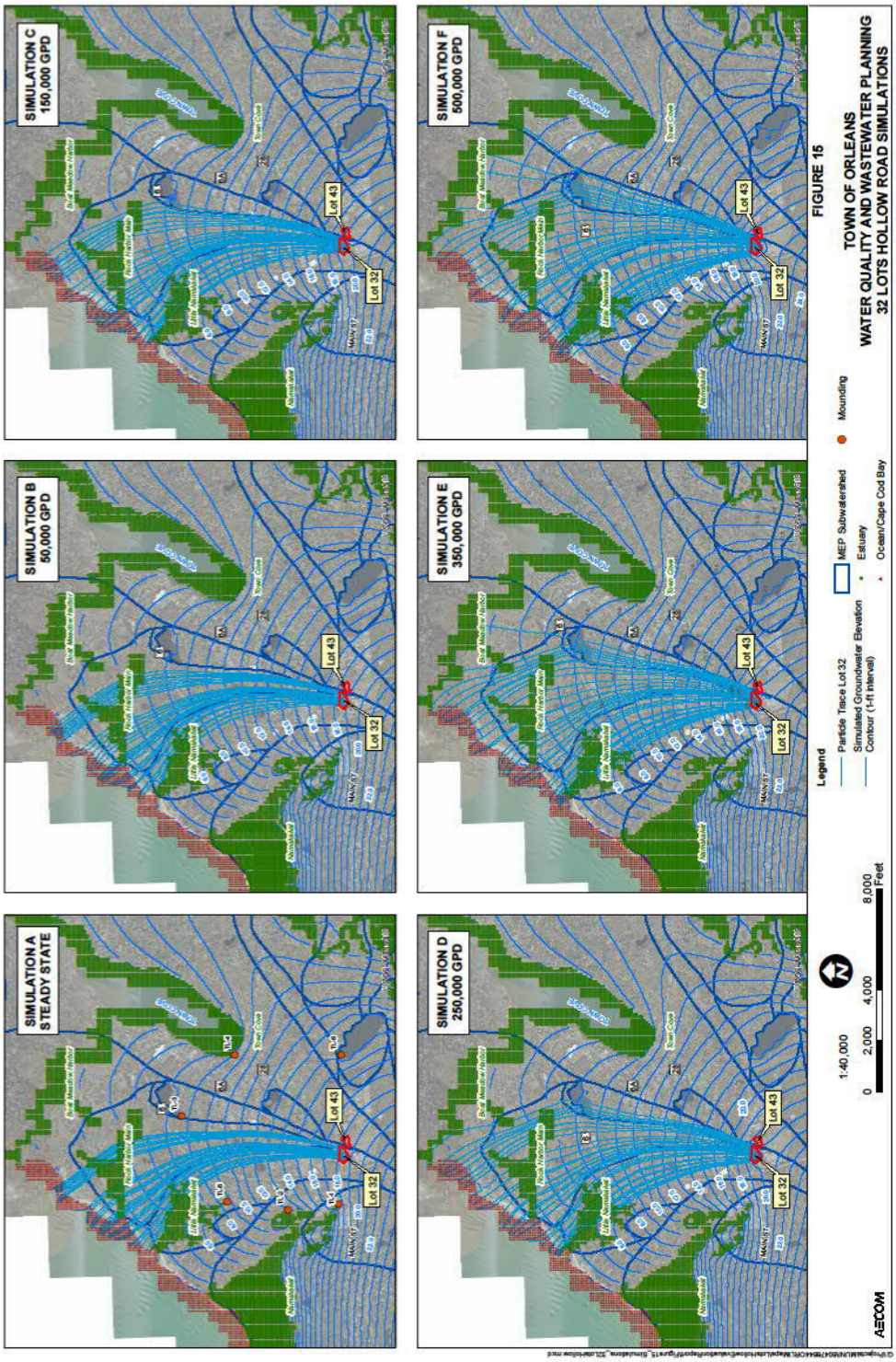

SIMULATION A
STEADY STATE
SIMULATION B
50,000 GPD
SIMULATION C
150,000 GPD
SIMULATION D
250,000 GPD
SIMULATION E
350,000 GPD
SIMULATION F
500,000 GPD
Lot 43
Lot 32
Legend
Particle Trace Lot 32
Simulated Groundwater Elevation Contour (1-ft interval)
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
Mounding
1:40,000
0 2,000 4,000 8,000
Feet
AECOM
FIGURE 15
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
32 LOTS HOLLOW ROAD SIMULATIONS

TABLE 15
ESTIMATED SITE GROUNDWATER MOUND – 32 LOTS HOLLOW ROAD

32 Lots Hollow Road Discharge (gpd)	32 Lots Hollow Road Maximum Simulated Mound (ft)
0	--
50,000	0.98
150,000	2.82
250,000	4.41
350,000	5.86
500,000	7.86

Groundwater mounding at several additional locations (TL-1, TL-2, TL-3, TL-4, TL-5, and TL-6) were also noted (Simulation A, Figure 15). Table 16 summarizes the model estimated groundwater mounding at each location.

TABLE 16
ESTIMATED REGIONAL GROUNDWATER MOUND – 32 LOTS HOLLOW ROAD

	Watershed (mounding in feet)					
Discharge (gpd)	**Namskaket (TL-1)**	**Namskaket (TL-2)**	**Cedar Pond (TL-3)**	**Town Cove (TL-4)**	**Little Namskaket (TL-5)**	**Crystal Lake (TL-6)**
150,000	0.303	0.191	0.094	0.066	0.082	0.150
250,000	0.504	0.319	0.157	0.110	0.136	0.250
350,000	0.705	0.446	0.220	0.155	0.190	0.350
500,000	1.007	0.637	0.315	0.221	0.272	0.499

Particle tracks were started at the same cells where the discharge was simulated; MODPATH then simulated the particle trajectories (pathlines) until they end at a discharge point (estuary (drain) or ocean/Cape Cod Bay (general head boundary)). As the discharge rates increase the particles tend to spread out. The trajectories are three-dimensional and a significant part of their near-discharge trajectory is downward, deep into the aquifer, followed by horizontal movement, followed by upward flow to discharge points. The flow downward, through deep layers of the aquifer and then back to the surface, results in relatively long travel times. Table 17 summarizes the minimum, maximum, range, and average travel times for particles from 32 Lots Hollow Road to the discharge point (estuary, Cape Cod Bay).

TABLE 17
ESTIMATED TRAVEL TIME – 32 LOTS HOLLOW ROAD

	Travel Time (years) to Discharge Boundary			
Discharge (gpd)	**Minimum**	**Maximum**	**Range**	**Average**
0	65	144	79	114
50,000	60	290	230	129
150,000	60	401	341	155
250,000	61	337	277	157
350,000	64	477	413	186
500,000	77	910	833	262

Figure 16 shows an oblique view of the particle pathlines originating from 32 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle pathlines, discharge of the effluent is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries.

Table 18 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

TABLE 18
ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 32 LOTS HOLLOW ROAD

	Discharge (gpd)					
Watershed	**0**	**50,000**	**150,000**	**250,000**	**350,000**	**500,000**
Namskaket Creek	572,161	574,345	578,714	583,075	587,439	594,004
Difference		2,185	6,553	10,914	15,278	21,843
Percent change		0.4	1.1	1.9	2.7	3.8
Little Namskaket Creek	86,230	86,673	87,562	88,449	89,338	90,675
Difference		444	1,332	2,219	3,109	4,445
Percent change		0.5	1.5	2.6	3.6	5.2
Rock Harbor	93,543	93,812	94,350	94,887	95,426	96,234
Difference		269	807	1,344	1,883	2,691
Percent change		0.3	0.9	1.4	2.0	2.9
Boat Meadow River	102,240	102,545	103,153	103,759	104,368	105,283
Difference		304	912	1,519	2,128	3,042
Percent change		0.3	0.9	1.5	2.1	3.0
Town Cove	486,482	487,583	489,787	491,986	494,189	497,496
Difference		1,102	3,305	5,504	7,707	11,014
Percent change		0.2	0.7	1.1	1.6	2.3
Other	1,321,133	1,323,169	1,327,250	1,331,327	1,335,407	1,341,536
Difference		2,037	6,117	10,194	14,274	20,404
Percent change		0.2	0.5	0.8	1.1	1.5
Cape Cod Bay	933,856	934,986	937,235	939,513	941,770	945,135
Difference		1,130	3,379	5,656	7,913	11,279
Percent change		0.1	0.4	0.6	0.8	1.2
Pleasant Bay	970,763	971,721	973,650	975,570	977,493	980,387
Difference		958.4	2,887.4	4,807.3	6,730.5	9,624.7
Percent change		0.1	0.3	0.5	0.7	1.0

Flow (ft^3/day)

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each discharge boundary. For each fate and transport simulation, nitrate was assumed to be discharged at a concentration of 10 mg/L from 32 Lots Hollow Road and the simulation was run for 40,000 days or just under 110 years. Nitrate was assumed to be a conservative element, meaning there was no retardation or degradation. Longitudinal dispersion was set to 10.

In order to calculate the flow to each of the boundaries, AECOM used the USGS "flow budget" tool included in the GMS pre and post processer. This tool reports on the flow in and out of selected cells and boundary conditions. For example, AECOM selected a set of cells that represent Namskaket Creek and the flow budget tool reported the flow through those drain cells. This was completed separately for the drain cells representing Little Namskaket and Rock Harbor. Flow through the general head boundary cells, representing Cape Cod flow into Cape Cod Bay, was similarly used using the flow budget tool.

Table 19 summarizes the nitrate load to each estuary or Cape Cod Bay under different discharge scenarios. Based on the travel times predicted by the particle pathlines, the simulation time of 40,000 days may not have been sufficient to reach steady state conditions. As a result, the mass load estimates maybe be underestimates. However the results do indicate the relative increase in load for the different discharge scenarios.

TABLE 19
ESTIMATED NITRATE LOAD TO WATERSHEDS – 32 LOTS HOLLOW ROAD

Estimated Nitrate Load (kg/year)	Discharge (gpd)	50,000	150,000	250,000	350,000	500,000
	Cape Cod Bay	298	853	1,499	2,099	2,809
	Namskaket Creek	0	0	48	235	808
	Little Namskaket Creek	217	565	765	898	1,047
	Rock Harbor	114	233	300	355	422
	Boat Meadow River	1	7	16	26	47
	Town Cove	0	91	438	1,018	2,112
	Other*	0	0	0	0	0
	Total Nitrate Load	630	1,749	3,066	4,631	7,245
Nitrate Load Summary	Nitrate Load to Cape Cod Bay	47%	49%	49%	45%	39%
	Nitrate Load to an Estuary	48%	39%	31%	26%	22%
	Nitrate Load to Town Cove	0%	5%	14%	22%	29%

Notes:
The model simulations were run to 40,000 days under steady-state conditions.
* Atlantic Ocean, Pleasant Bay, and other surface waters not included above.

5.5.2. 43 Lots Hollow Road Groundwater Discharge

Similar to Figure 15, Figure 17 shows the groundwater contours and particle pathlines for different discharge scenarios for 43 Lots Hollow Road. The mound heights are shown in Table 20 and are sufficiently low that there is enough separation to the land surface.

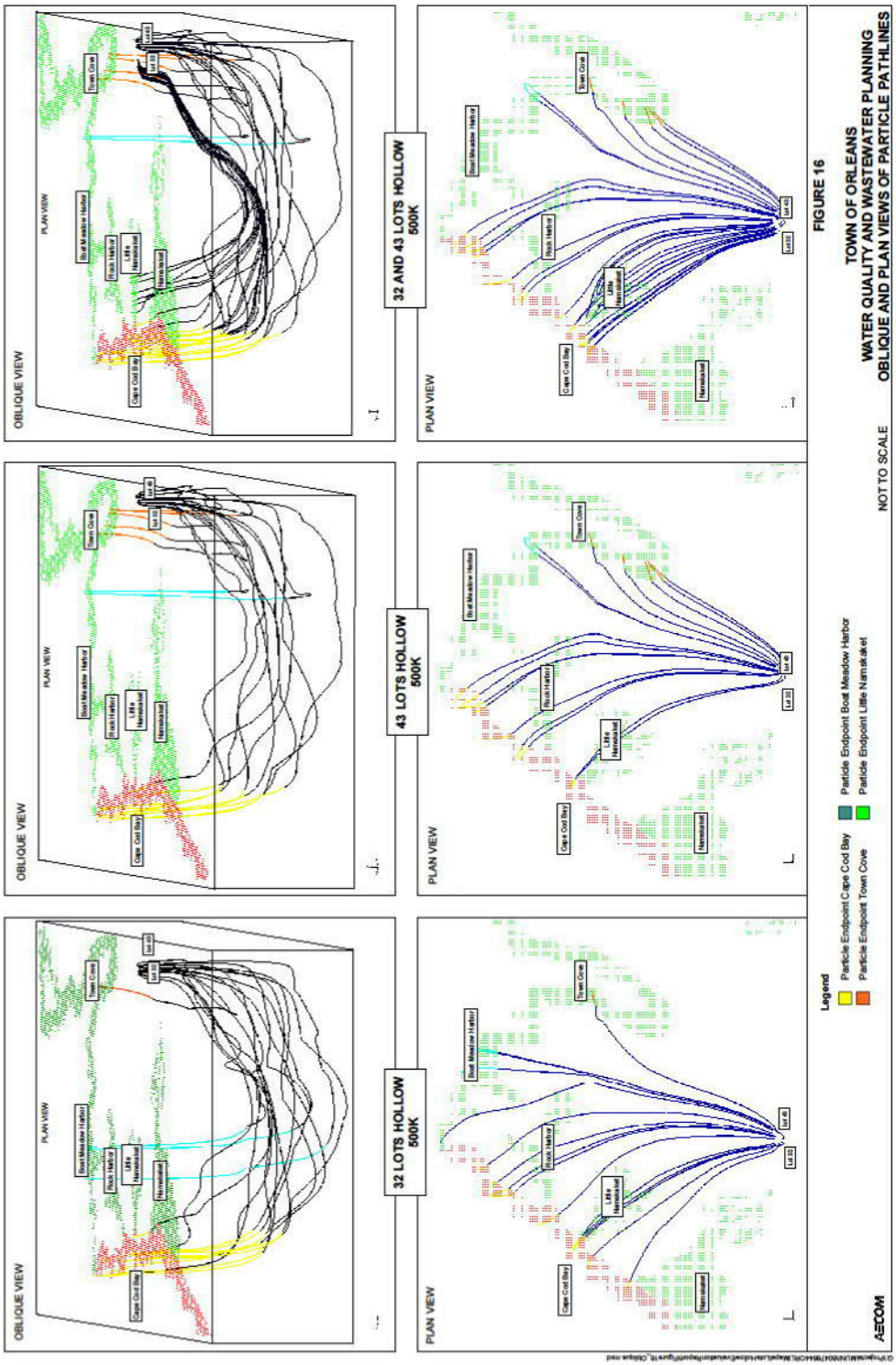
TABLE 20
ESTIMATED SITE GROUNDWATER MOUND – 43 LOTS HOLLOW ROAD

43 Lots Hollow Road Discharge (gpd)	43 Lots Hollow Road Maximum Simulated Mound (ft)
0	--
50,000	1.03
150,000	2.95
250,000	4.60
350,000	6.11
500,000	8.20

Mounding was also observed at the far-afield locations shown on Figure 17. Table 21 summarizes the mounding at a number of locations.

TABLE 21
ESTIMATED REGIONAL GROUNDWATER MOUND – 43 LOTS HOLLOW ROAD

	Watershed (mounding in feet)					
Discharge (gpd)	**Namskaket (TL-1)**	**Namskaket (TL-2)**	**Cedar Pond (TL-3)**	**Town Cove (TL-4)**	**Little Namskaket (TL-5)**	**Crystal Lake (TL-6)**
150,000	0.258	0.171	0.067	0.087	0.090	0.168
250,000	0.430	0.285	0.112	0.144	0.150	0.280
350,000	0.602	0.399	0.157	0.202	0.209	0.392
500,000	0.860	0.57	0.224	0.289	0.299	0.559


OBLIQUE VIEW
PLAN VIEW
32 AND 43 LOTS HOLLOW 500K
43 LOTS HOLLOW 500K
32 LOTS HOLLOW 500K
Boat Meadow Harbor
Town Cove
Rock Harbor
Little Namskaket
Namskaket
Cape Cod Bay
Legend
Particle Endpoint Cape Cod Bay
Particle Endpoint Town Cove
Particle Endpoint Boat Meadow Harbor
Particle Endpoint Little Namskaket
NOT TO SCALE
AECOM
FIGURE 16
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
OBLIQUE AND PLAN VIEWS OF PARTICLE PATHLINES

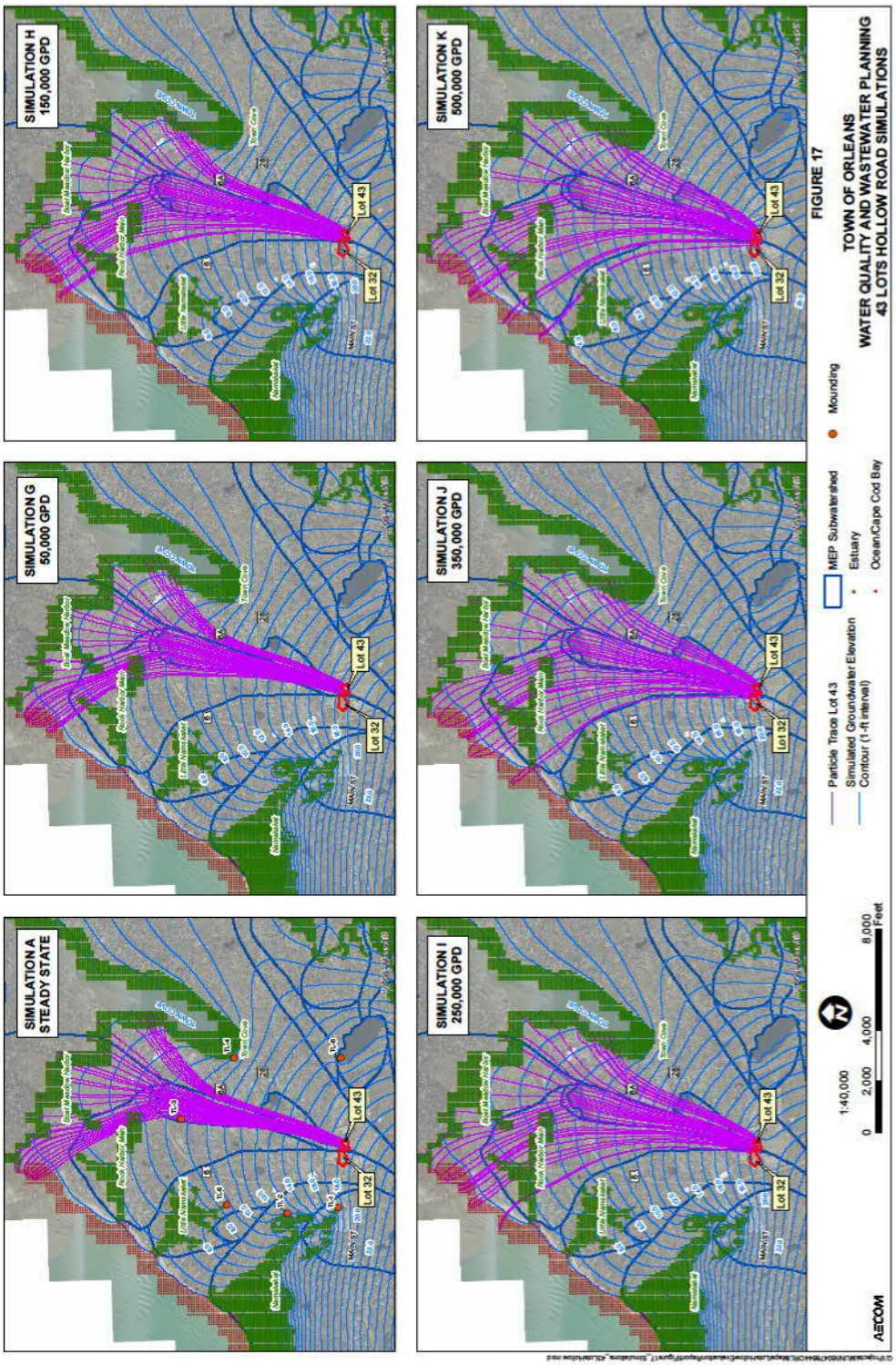

SIMULATION A
STEADY STATE
SIMULATION G
50,000 GPD
SIMULATION H
150,000 GPD
SIMULATION I
250,000 GPD
SIMULATION J
350,000 GPD
SIMULATION K
500,000 GPD
Lot 43
Lot 32
Particle Trace Lot 43
Simulated Groundwater Elevation
Contour (1-ft interval)
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
Mounding
1:40,000
0 2,000 4,000 8,000 Feet
AECOM
FIGURE 17
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
43 LOTS HOLLOW ROAD SIMULATIONS

Table 22 summarizes the minimum, maximum, range, and average travel times for particles to travel between 43 Lots Hollow Road and the discharge point (estuary, Cape Cod Bay).

TABLE 22
ESTIMATED TRAVEL TIME – 43 LOTS HOLLOW ROAD

	Travel Time (years) to Discharge Boundary			
Discharge (gpd)	**Minimum**	**Maximum**	**Range**	**Average**
0	90	368	278	196
50,000	54	322	268	167
150,000	45	756	711	190
250,000	44	1,005	961	200
350,000	41	1,010	969	213
500,000	40	894	854	220

Figure 16 shows an oblique view of the particle pathlines originating from 43 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle pathlines, discharge is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries. Table 23 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each watershed.

Table 24 summarizes the nitrate load to each watershed under different discharge scenarios. Similar to above the transport simulations were set to around 110 years which is less time than it takes for all the particles to reach a discharge boundary. For that reason the nitrate loadings may be slight under-estimates, however are sufficient to understand the relative differences in loading rates for different discharge scenarios.

TABLE 23
ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 43 LOTS HOLLOW ROAD

Watershed	Discharge (gpd)					
	0	50,000	150,000	250,000	350,000	500,000
Namskaket Creek	572,161	574,120	578,032	581,951	587,822	591,737
Difference		1,959	5,871	9,790	15,661	19,576
Percent change		0.3	1.0	1.7	2.7	3.4
Little Namskaket Creek	86,230	86,658	87,515	88,372	89,659	90,518
Difference		428	1,286	2,142	3,430	4,288
Percent change		0.5	1.5	2.5	4.0	5.0
Rock Harbor	93,543	93,812	94,352	94,890	95,698	96,236
Difference		269	809	1,347	2,155	2,693
Percent change		0.3	0.9	1.4	2.3	2.9
Boat Meadow River	102,240	102,550	103,169	103,786	104,714	105,332
Difference		309	928	1,546	2,474	3,092
Percent change		0.3	0.9	1.5	2.4	3.0
Town Cove	486,482	487,656	490,004	492,350	495,871	498,219
Difference		1,174	3,522	5,869	9,389	11,738
Percent change		0.2	0.7	1.2	1.9	2.4
Other	1,321,133	1,323,353	1,327,798	1,332,247	1,336,693	1,343,373
Difference		2,220	6,665	11,115	15,560	22,241
Percent change		0.2	0.5	0.8	1.2	1.7
Cape Cod Bay	933,856	934,941	937,100	939,254	942,502	944,659
Difference		1,085	3,244	5,398	8,646	10,803
Percent change		0.1	0.3	0.6	0.9	1.2
Pleasant Bay	970,763	971,744	973,716	975,692	978,645	980,622
Difference		981.4	2,953.1	4,929.6	7,882.4	9,859.6
Percent change		0.1	0.3	0.5	0.8	1.0

TABLE 24
ESTIMATED NITRATE LOAD TO WATERSHEDS – 43 LOTS HOLLOW ROAD

	Discharge (gpd)	50,000	150,000	250,000	350,000	500,000
Estimated Nitrate Load (kg/year)	Cape Cod Bay	6	190	456	775	1,454
	Namskaket Creek	0	0	0	0	1
	Little Namskaket Creek	0	28	235	515	841
	Rock Harbor	109	229	296	353	427
	Boat Meadow River	5	13	24	38	64
	Town Cove	320	1,151	2,067	3,018	4,477
	Other*	0	0	0	0	0
	Total Nitrate Load	441	1,611	3,077	4,699	7,264
Nitrate Load Summary	Nitrate Load to Cape Cod Bay	1%	12%	15%	16%	20%
	Nitrate Load to an Estuary	26%	17%	18%	19%	18%
	Nitrate Load to Town Cove	73%	71%	67%	64%	62%

5.5.3. 32 and 43 Lots Hollow Road Groundwater Discharge

This set of simulations considers the situation where both Lots Hollow sites are used and the groundwater discharge is distributed equally between the two. Figure 18 shows the groundwater contours and particle pathlines for different discharge scenarios for 43 Lots Hollow Road. The mound heights at the site are shown in Table 25 and are sufficiently low that there is enough separation to the ground surface.

TABLE 25
ESTIMATED SITE GROUNDWATER MOUND – 32 AND 43 LOTS HOLLOW ROAD

32/43 Lots Hollow Road Discharge (gpd)	Lot 32/43 Lots Hollow Road Maximum Simulated Mound (ft)
0	--
50,000	0.67
150,000	1.95
250,000	3.15
350,000	4.26
500,000	5.82

Mounding was also observed at far-afield locations. Table 26 summarizes the mounding at a number of locations, shown on Figure 18.

TABLE 26
ESTIMATED REGIONAL GROUNDWATER MOUND – 32 AND 43 LOTS HOLLOW ROAD

	Watershed (mounding in feet)					
Discharge (gpd)	**Namskaket (TL-1)**	**Namskaket (TL-2)**	**Cedar Pond (TL-3)**	**Town Cove (TL-4)**	**Little Namskaket (TL-5)**	**Crystal Lake (TL-6)**
150,000	0.280	0.181	0.092	0.067	0.084	0.159
250,000	0.467	0.302	0.153	0.111	0.140	0.265
350,000	0.654	0.423	0.215	0.156	0.196	0.371
500,000	0.933	0.604	0.307	0.223	0.280	0.529

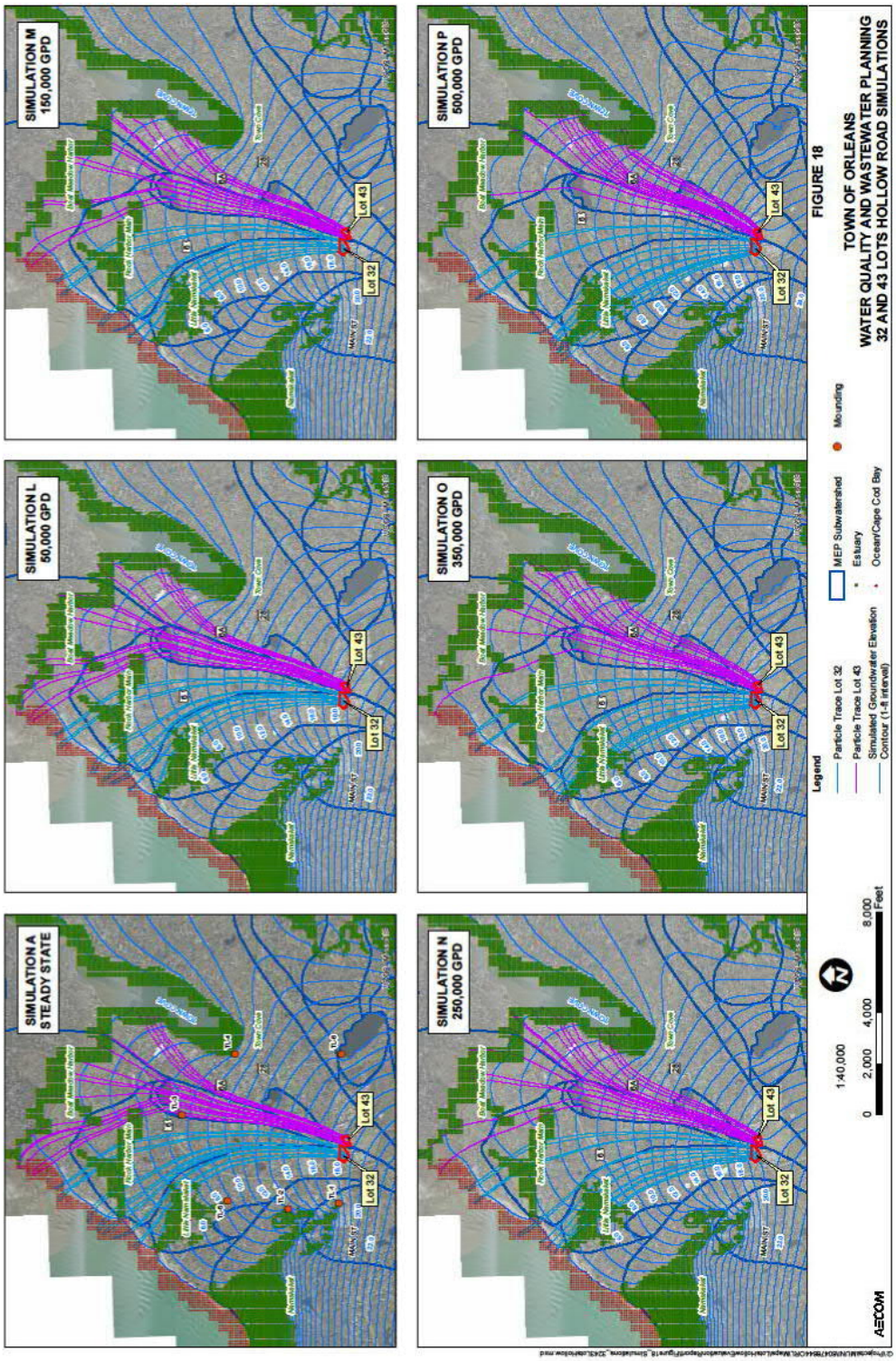

SIMULATION A
STEADY STATE
SIMULATION L
50,000 GPD
SIMULATION M
150,000 GPD
SIMULATION N
250,000 GPD
SIMULATION O
350,000 GPD
SIMULATION P
500,000 GPD
Lot 32
Lot 43
Legend
Particle Trace Lot 32
Particle Trace Lot 43
Simulated Groundwater Elevation Contour (1-ft interval)
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
Mounding
1:40,000
0 2,000 4,000 8,000 Feet
AECOM
FIGURE 18
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
32 AND 43 LOTS HOLLOW ROAD SIMULATIONS

Table 27 summarizes the minimum, maximum, range, and average travel times for particles to travel between 43 Lots Hollow Road and the discharge point (estuary, Cape Cod Bay).

TABLE 27
ESTIMATED TRAVEL TIME – 32 AND 43 LOTS HOLLOW ROAD

	Travel Time (years) to Discharge Boundary			
Discharge (gpd)	**Minimum**	**Maximum**	**Range**	**Average**
0	71	408	337	168
50,000	65	421	355	155
150,000	61	505	444	160
250,000	56	673	617	165
350,000	53	664	611	161
500,000	50	638	587	140

Figure 16 shows an oblique view of the particle traces originating from 43 Lots Hollow Road under the 500,000 gpd discharge scenario. Based on the particle traces, discharge is predominantly to Cape Cod Bay with a lesser component of discharge to estuaries. Table 28 compares the water budget with different discharge scenarios to the base case. This table demonstrates that as the discharge rate increases so does the relative discharge to each of the watersheds.

Finally, based on the flow field generated with each discharge scenario, MT3D, a fate and transport model was run to make a prediction of nitrate loading to each watershed. Table 29 summarizes the nitrate load to each watershed under different discharge scenarios. Similar to above the transport simulations were set to around 110 years which is less time than it takes for all the particles to reach a discharge boundary. For that reason the nitrate loadings may be slight under-estimates, however are sufficient to understand the relative differences in loading rates for different discharge scenarios.

TABLE 28
ESTIMATED FRESH WATER FLOW TO WATERSHEDS – 32 AND 43 LOTS HOLLOW ROAD

		Discharge (gpd)					
	Watershed	0	50,000	150,000	250,000	350,000	500,000
Flow (ft3/day)	Namskaket Creek	572,161	574,234	578,376	582,513	586,651	592,875
	Difference		2,073	6,215	10,352	14,490	20,714
	Percent change		0.4	1.1	1.8	2.5	3.6
	Little Namskaket Creek	86,230	86,666	87,539	88,411	89,284	90,596
	Difference		436	1,309	2,181	3,055	4,367
	Percent change		0.5	1.5	2.5	3.5	5.1
	Rock Harbor	93,543	93,812	94,351	94,889	95,427	96,236
	Difference		269	808	1,346	1,884	2,693
	Percent change		0.3	0.9	1.4	2.0	2.9
	Boat Meadow River	102,240	102,547	103,161	103,774	104,387	105,307
	Difference		307	920	1,533	2,146	3,067
	Percent change		0.3	0.9	1.5	2.1	3.0
	Town Cove	486,482	487,620	489,896	492,169	494,443	497,858
	Difference		1,138	3,414	5,687	7,961	11,376
	Percent change		0.2	0.7	1.2	1.6	2.3
	Other	1,321,133	1,323,262	1,327,526	1,331,787	1,336,049	1,342,455
	Difference		2,130	6,394	10,655	14,917	21,322
	Percent change		0.2	0.5	0.8	1.1	1.6
	Cape Cod Bay	933,856	934,965	937,164	939,371	941,595	944,897
	Difference		1,109	3,308	5,515	7,739	11,041
	Percent change		0.1	0.4	0.6	0.8	1.2
	Pleasant Bay	970,763	971,733	973,686	975,632	977,575	980,504
	Difference		970.1	2,923.0	4,869.6	6,812.1	9,741.4
	Percent change		0.1	0.3	0.5	0.7	1.0

TABLE 29
ESTIMATED NITRATE LOAD TO WATERSHEDS – 32 AND 43 LOTS HOLLOW ROAD

Estimated Nitrate Load (kg/year)	Discharge (gpd)	50,000	150,000	250,000	350,000	500,000
	Cape Cod Bay	298	853	1,499	2,099	2,809
	Namskaket Creek	0	0	48	235	808
	Little Namskaket Creek	217	565	765	898	1,047
	Rock Harbor	114	233	300	355	422
	Boat Meadow River	1	7	16	26	47
	Town Cove	0	91	438	1,018	2,112
	Other*	0	0	0	0	0
	Total Nitrate Load	630	1,749	3,066	4,632	7,245
Nitrate Load Summary	Nitrate Load to Cape Cod Bay	47%	49%	49%	45%	39%
	Nitrate Load to an Estuary	67%	71%	69%	68%	69%

5.5.4. Landfill Plume

In addition to the previous scenarios, selected flow fields generated for the above-discussed simulations were used to consider potential impacts to flow originating from the landfill. Figure 19 shows the flow field generated from discharging 250,000 gpd from 32 Lots Hollow Road, 43 Lots Hollow Road, and across both sites. In addition to showing the particles that originate from the groundwater discharge, these figures also show the particles that originate from the perimeter of the landfill.

In the no-discharge (steady-state) simulation, landfill particle traces tend to move due north or north-northeast with some particles discharging to Town Cove and further north at Boat Meadow Harbor. With the addition of a groundwater discharge at 32 Lots Hollow, groundwater from the landfill moves to the north-northeast such that all particles originating from the landfill appear to discharge to Town Cove. With the discharge at 43 Lots Hollow, most groundwater from the landfill moves slightly further to the east, with a few flowpaths ending in Boat Meadow Harbor. When the discharge is divided among both sites, flow from the landfill is similar to the 32 Lots Hollow simulations except the flow is slightly further to the north-northeast.

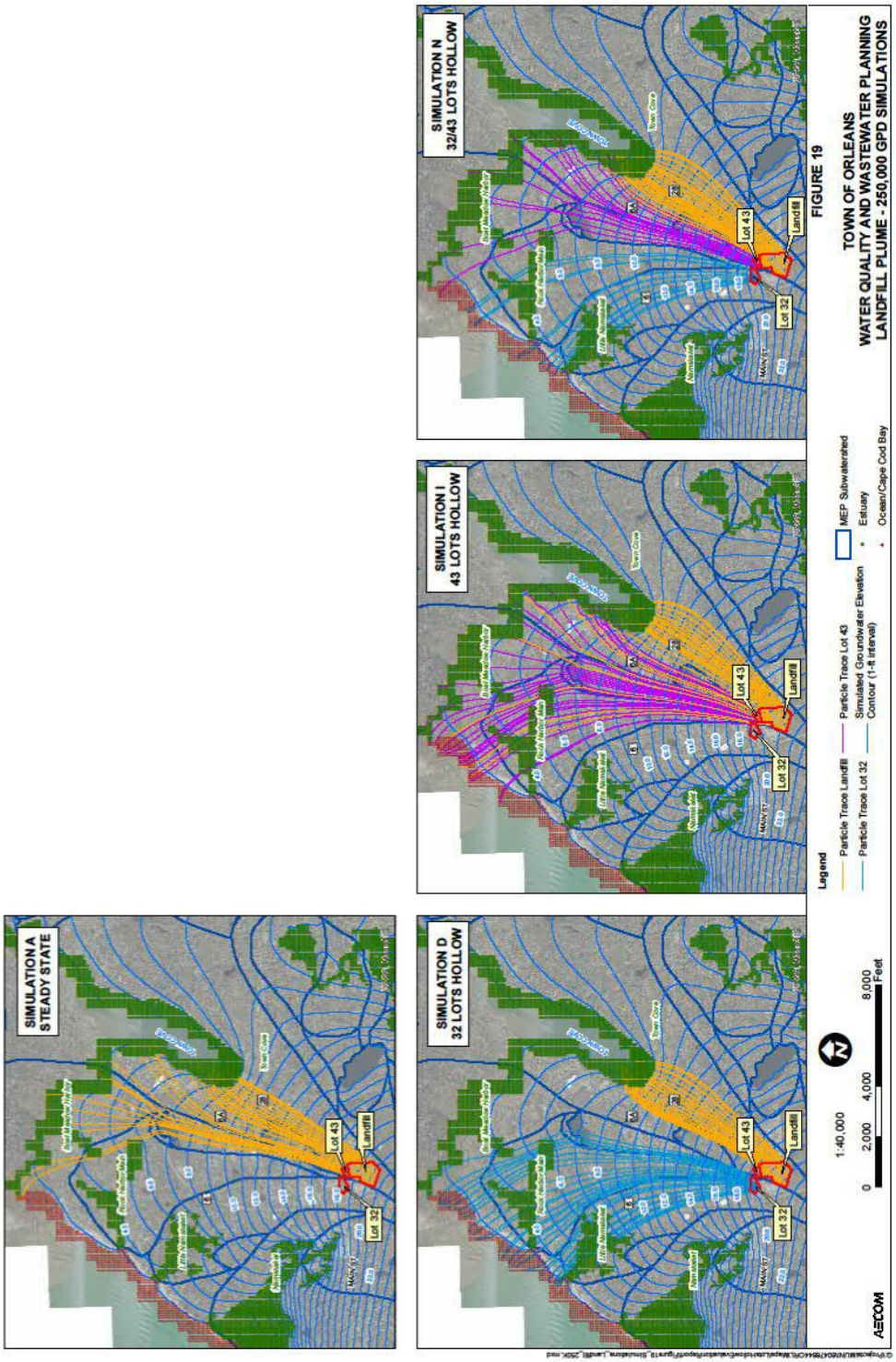

SIMULATION A
STEADY STATE
SIMULATION D
32 LOTS HOLLOW
SIMULATION I
43 LOTS HOLLOW
SIMULATION N
32/43 LOTS HOLLOW
Lot 43
Lot 32
Landfill
Legend
Particle Trace Landfill
Particle Trace Lot 43
Particle Trace Lot 32
Simulated Groundwater Elevation Contour (1-ft interval)
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
1:40,000
0
2,000
4,000
8,000
Feet
AECOM
FIGURE 19
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
LANDFILL PLUME - 250,000 GPD SIMULATIONS

Figure 20 shows model simulations similar to Figure 19, except for the discharge rate being increased to 500,000 gpd. With the additional discharge to 32 Lots Hollow Road, particles originating from the landfill are deflected further to the northeast with all the landfill flow entering Town Cove. When the 500,000 gpd is shifted to 43 Lots Hollow Road, the majority of the particle traces originating from the landfill flow to the north-northeast while a few isolated particles are diverted northwest to Cape Cod Bay. In this scenario, a few isolated particles head east to the headwaters of Pleasant Bay. Finally discharging to both 32 and 43 Lots Hollow Road, particles originating from the landfill are deflected northeastward indicating that the landfill plume discharges to the south and east of Town Cove.

5.5.5. Public Water Supplies

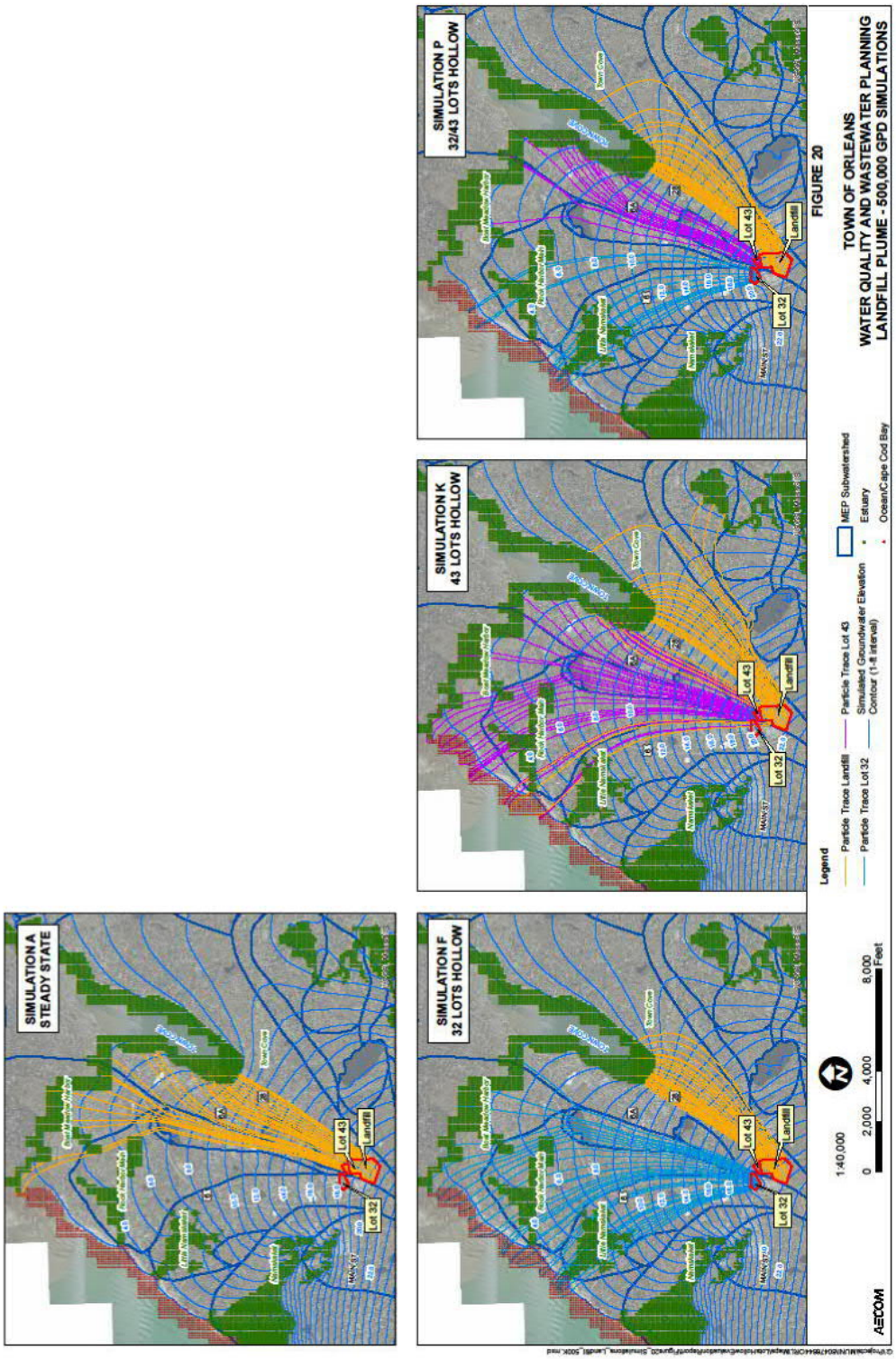
Figure 21 presents an analysis of the proposed groundwater discharge on the water supply wells of Orleans and Harwich. The first scenario (Simulation A) on Figure 21 shows steady-state baseline conditions with the wells pumping steady-state baseline conditions with the wells pumping at 2002 average pumping conditions, with no groundwater discharge at any of the Lots Hollow Road sites. The zones of contribution for the Town wells are illustrated using grey reverse particle traces. Particle traces estimating the path of the landfill plume are yellow while particle traces from 32 Lots Hollow Road (no discharge) are shown in blue.

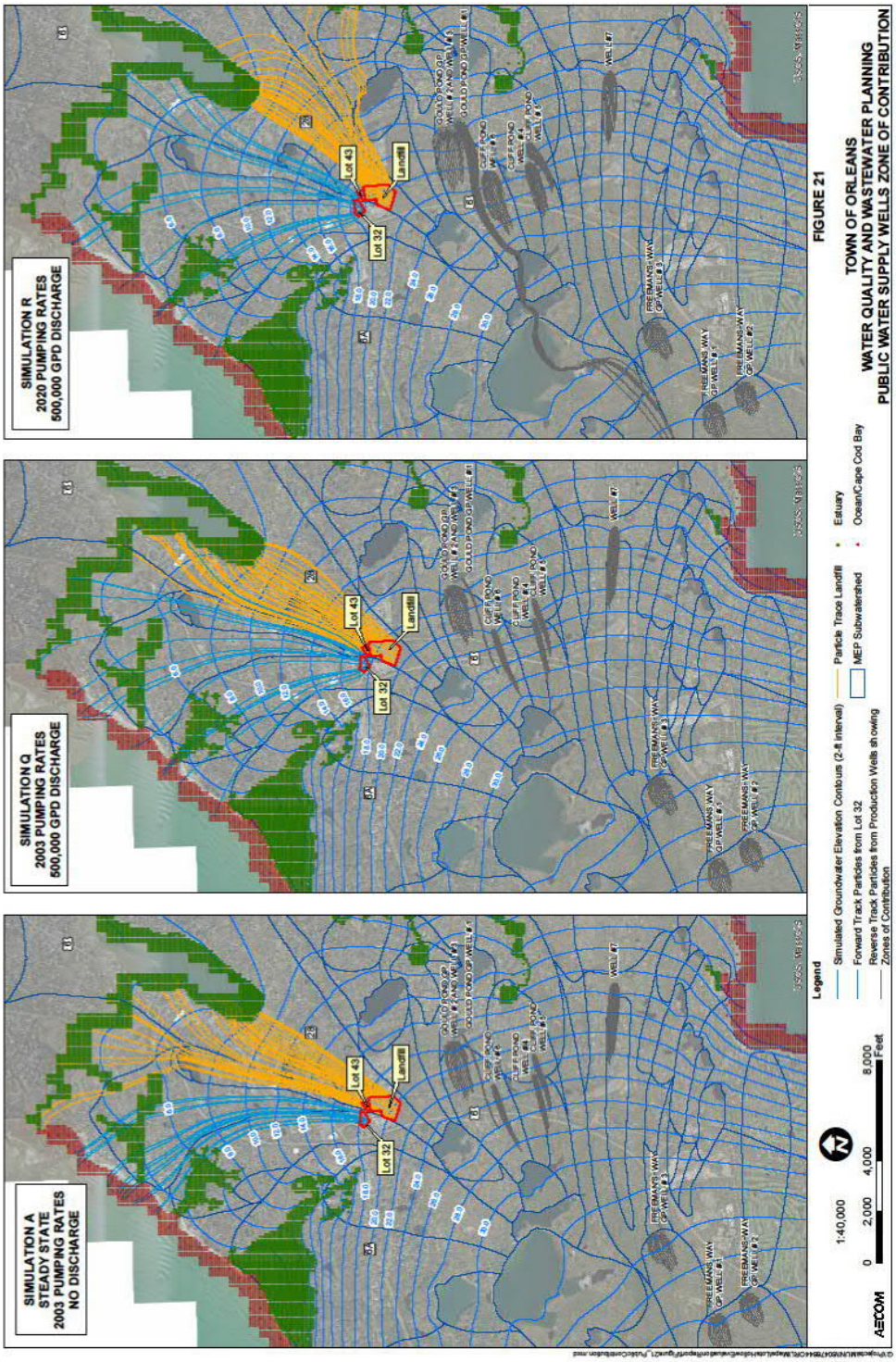
All of the water supply wells are located outside the subwatersheds of the landfill and proposed groundwater discharge sites. The supply wells are located in subwatersheds of Pleasant Bay, while the landfill and 32 Lots Hollow Road are located in the Town Cove and Little Namskaket Creek subwatersheds, respectively. The 43 Lots Hollow Road site is located in the Town Cove Watershed.

The distance between the proposed discharge at 32 Lots hollow and the closest water supply well (Town of Orleans's Goulds Pond Well #2) is approximate 4,400 feet to the southwest. The distance between Goulds Pond Well #2 and the closest point of the Landfill is approximately 2,900 feet.

The second scenario (Simulation Q) is identical to the first with the exception of a 500,000 gpd discharge at 32 Lots Hollow. As discussed in Section 5.5.4, the groundwater discharge influences the path of the landfill plume by it moving further to the east and north. However, the particle traces from the discharge and landfill plume do not move south or southeast towards the water supply wells or zones of contribution.

Scenario R simulates the water supply wells pumping at higher rates (USGS projected 2020 pumping rates) with the 500,000 gpd discharge. As with Scenario Q, the discharge with the increased pumping appears to have no noticeable impact on any of the water supply well's zones of contribution. The zones of contribution are slightly larger in this simulation, however this is due to the increased pumping rates of the wells. A few particle traces from the landfill appear to flow into a subwatershed of Pleasant Bay. This did not occur at a discharge rate of 250,000 gpd which is the anticipated buildout flow for the Downtown Area.


SIMULATION A
STEADY STATE
SIMULATION F
32 LOTS HOLLOW
SIMULATION K
43 LOTS HOLLOW
SIMULATION P
32/43 LOTS HOLLOW
Lot 43
Landfill
Lot 32
Legend
Particle Trace Landfill
Particle Trace Lot 43
Particle Trace Lot 32
Simulated Groundwater Elevation Contour (1-ft interval)
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
1:40,000
0 2,000 4,000 8,000 Feet
AECOM
FIGURE 20
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
LANDFILL PLUME - 500,000 GPD SIMULATIONS


SIMULATION A
STEADY STATE
2003 PUMPING RATES
NO DISCHARGE
SIMULATION Q
2003 PUMPING RATES
500,000 GPD DISCHARGE
SIMULATION R
2020 PUMPING RATES
500,000 GPD DISCHARGE
Lot 43
Lot 32
Landfill
Legend
Simulated Groundwater Elevation Contours (2-ft interval)
Forward Track Particles from Lot 32
Reverse Track Particles from Production Wells showing Zones of Contribution
Particle Trace Landfill
MEP Subwatershed
Estuary
Ocean/Cape Cod Bay
1:40,000
0
2,000
4,000
8,000
Feet
AECOM
FIGURE 21
TOWN OF ORLEANS
WATER QUALITY AND WASTEWATER PLANNING
PUBLIC WATER SUPPLY WELLS ZONE OF CONTRIBUTION

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6. POTENTIAL IMPACTS

The potential impacts resulting from the proposed groundwater discharge fall into two general categories: 1) potential water quality impacts and 2) potential groundwater mounding impacts. Although the discharge will be treated to high levels, the discharge may contain slightly higher levels of nutrients and other constituents compared to the ambient groundwater. Potential mounding impacts include the discharge of groundwater in areas where groundwater does not presently discharge and the rise of water levels adjacent to the wick and on surrounding properties.

Groundwater mounding and water quality impacts were modeled using worst-case input parameters. These included using high water-table conditions, a discharge rate that will likely exceed the actual discharge rate of the WWTF, and a nitrate effluent concentration of 10 mg/L. The actual discharge concentration would likely to be closer to 3 to 6 mg/L depending on the MassDEP discharge permit and daily plant operations.

6.1. Potential Groundwater Mounding Impacts

The primary site of proposed discharge is at 32 Lots Hollow Road, with the reserve discharge location being 43 Lots Hollow Road. Based on groundwater model simulations, groundwater mounding would not impact any structures or nearby properties. In general, the average or high water level elevations from groundwater mounding is insignificant and well below surrounding surface elevations.

The groundwater mounding simulation indicates that a rise of approximately 0.3 feet at a discharge of 150,000 gpd, and a rise of up to 1.0 foot at discharge of 500,000 gpd, may occur at the eastern/southeastern boundary of Namskaket Creek (Figure 15). Similarly, the groundwater model predicts a potential rise of approximately one (150,000 gpd discharge) to four (500,000 gpd discharge) inches at Little Namskaket and north of Namskaket Creek. Details of the groundwater mounding scenarios are discussed in Section 5.5.

Although this groundwater mound prediction is only an approximation, the increase in groundwater elevation in the vicinity of Namskaket and Little Namskaket Creek has the potential to alter the hydrology of the marsh sufficiently that a vegetation change may occur. The portion of the Namskaket Creek that is within the area of the predicted groundwater mound is an area which includes both a saltmarsh as well as a brackish plant community associated with Hurley's Bog (Figure 15, Simulation A, TL-1) on the south side of the Cape Cod Rail Trail (SMAST, 2016).

Typically, the hydrology driving the presence of hydrophytic plant species is located within the top 12-inches of the soil; therefore, a change in this regime of 3 to 12 inches could result in a substantial change to the hydrological conditions experienced by plant species present. Since the discharge would represent an increase in freshwater input to the marsh, it is possible that a shift from salt marsh to freshwater plant species could occur. These conditions would be particularly favorable to an increase in extent of Phragmites, which already exists in the area (SMAST, 2016). The extent of any vegetation shift is difficult to predict. Therefore, monitoring of the plant species distribution within the eastern/southeastern portion of Namskaket Creek is recommended just prior to and once the discharge commences, in order to document any shifts in plant cover from salt water to freshwater species, including Phragmites.

Similar to the previous study conducted by SMAST, it is recommended that long-term permanent monitoring plots be established in Namskaket Creek in the vicinity of the predicted mount in order to annually monitor plant community composition, and thereby document any changes over time. If any changes to the salt marsh community were to occur, such as expansion in Phragmites cover, mitigation measures such as restoration or replication of a salt marsh in the vicinity or payment to the Commonwealth's in-lieu fee administered by the Massachusetts Department of Fish and Game should occur.

It should be noted that a recent study conducted by USGS (USGS, 2016) indicated that as a result of sea level rise, groundwater levels on Cape Cod are predicted to rise as high as 2.11 feet, with a more nominal rise of 0.1 foot near inland streams. Given these predictions, it is likely that any effect of the groundwater mounding predicted to occur as a result of the proposed groundwater discharge would be more than offset by changes likely to occur as a result of sea level rise over a longer time period.

It is possible that floodplains may be slightly affected as the water table may slightly increase in elevation in some low elevation areas around the marshes. It is also possible that floodplain extent may increase nominally as a result of the groundwater mounding predicted, although any increase would be unlikely to raise the floodplain elevation by a half foot or more, which would trigger a modification to the mapped floodplain. However, any increase is likely to be dwarfed by predicted sea level rise.

The groundwater mounding simulation also predicts a rise in groundwater elevations below Cedar Pond and Crystal Lake, ranging from less than one to approximately four inches, depending on the discharge volume. The locations of groundwater mounding are shown on Figure 15, Simulation A, at locations TL-3 and TL-6, respectively. As indicated above, this increase is likely to be offset by sea level rise. However monitoring may be appropriate to document any vegetation changes due to changes in the water levels of these water bodies.

6.2. Potential Water Quality Impacts

6.2.1. Discharge Water Quality

Discharge from the WWTF is expected to be within water quality standards set by the state. As noted in the model simulations, the effluent discharged will be widely distributed across several watersheds. This is primarily due to the relatively flat water table.

6.2.2. Watershed Nitrate Loads

The elimination of septic systems will result in long-term improvements in groundwater quality due to the removal of septic systems and their high nitrate discharge. No significant short-term impacts on surface water quality are expected. It is likely that improvement in groundwater quality will eventually lead to better surface water quality, as groundwater moves from inland areas to coastal discharge areas, or toward ponds from tributary areas. When most of the effluent-impacted groundwater eventually emerges in coastal waters, it would do so offshore, and in sufficiently well-mixed areas. Water quality improvements to estuaries would occur by removing septic systems whose discharge flows to salt marshes, tidal creeks and/or nitrate impacted estuaries, treating the wastewater, and discharging the effluent further upgradient in the watershed where the effluent impacted groundwater would flow deep in the aquifer below the estuaries to coastal waters that would not be impacted by the discharge. The discharge to coastal waters would not occur until many years after the initiation of treatment and disposal activities.

The modelling results indicate that freshwater flow and nitrate load from the discharged effluent will eventually reach Cape Cod Bay, Little Namskaket Creek (MA 96-26), Namskaket Creek (MA 96-27), and Town Cove (MA 96-68), as well as a smaller proportion discharging to Rock Harbor (MA 96-16) and Boat Meadow River (MA 95-15). However, the discharge will not reach these receiving water bodies for approximately 100 years. Rock Harbor Creek (MA 96-16) is not identified as impaired for nitrogen in either the MassDEP 2014 303(d) list of impaired waters, nor in the draft 2016 303(d) list of impaired waters. Namskaket Creek, Little Namskaket Creek, Rock Harbor Creek, Boat Meadow River, and Town Cove are all listed as impaired for fecal coliform in the current 303(d) list, and covered under a TMDL for this water quality constituent. However, the draft 2016 303(d) list proposes removing the fecal coliform impairment associated with Town Cove. The proposed groundwater discharge from the WWTF is expected to be within water quality standards set by the Commonwealth and would therefore comply with TMDL requirements.

Cape Cod Bay and Boat Meadow River have not been evaluated by MEP. Namskaket and Little Namskaket Creek, Rock Harbor, and Town Cove are all evaluated in MEP reports that identify nitrogen loading thresholds based on hydrodynamic and water quality modelling of these estuarine systems (Howes et. al. 2007a, b and c; Howes et. al. 2012). The MEP modelling analysis of both the Namskaket and Little Namskaket Creek marsh systems indicates that they are still able to assimilate additional nitrogen, without adverse water quality and benthic habitat impacts. The MEP analysis indicates that Rock Harbor and Town Cove cannot assimilate additional nitrogen without adverse water quality and benthic habitat impacts, and that the existing nitrogen loads are already in excess of the target watershed loads that would maintain a healthy aquatic ecosystem. The residual nitrogen remaining after treatment will increase the nitrogen loading to both Namskaket Creek and Little Namskaket Creek, but the loading would still be below their respective MEP nitrogen load target (Table 30).

The nitrogen loading to the Town Cove and Rock Harbor sub-watersheds will be reduced as a result of the proposed discharge (Table 29), which will benefit these receiving waters that are already impaired for nutrients and adversely affect by current nitrogen loading. Although Boat Meadow River is listed as impaired for estuarine bio assessments on the current 303(d) list, which typically is related to excess nitrogen, there is no TMDL established or MEP report for Boat Meadow River, so it is not possible to quantitatively evaluate the change in nitrogen loading on this receiving water body. However, the nitrate load to Boat Meadow River that will occur as a result of the discharge is only slightly greater than the current nitrate load, and is expected to result in minimal if any change on the receiving water quality. Overall, the proposed discharge at Lots Hollow Road is anticipated to be within the MEP recommended nitrogen loading for all receiving watersheds and will reduce nitrogen loading to two receiving waterbodies (Rock Harbor and Town Cove) and consequently is not expected to result in an adverse effect on water quality or benthic habitat. Because Cape Cod Bay experiences a tremendous amount of daily flushing, it is not anticipated that the additional nitrogen loading to the Bay would result in adverse water quality or benthic habitat impacts, particularly when coupled with lowered nitrogen loading as a result of discontinued use of septic systems. Table 29 summarizing load removed, returned, added, TMDL, and balance by watershed.

TABLE 30
ESTIMATED WATERSHED NITRATE LOADS

	Present Watershed Nitrate Load ((kg/yr)			Estimated Buildout Watershed Nitrate Load ((kg/yr)				
Location	Present Watershed Load[1]	Target Threshold Watershed Load[1]	Allowable Additional Watershed Load[2]	Watershed Nitrate Load to WWTF	Watershed Nitrate Load from WWTF	Net Increase / (Decrease) in Watershed Nitrate Load	Watershed Load with WWTF	Future Allowable Additional Watershed Load
Cape Cod Bay	ND	ND	ND	ND	2,809	ND	ND	ND
Namskaket Creek	3,446	16,750	13,304	470	808	338	3,784	12,966
Little Namskaket Creek	2,797	4,650	1,853	825	1,047	222	3,019	1,631
Rock Harbor	9,066	3,721	ND	3,000	422	(2,578)	6,488	0
Boat Meadow River	ND	ND	ND	36	47	ND	ND	ND
Town Cove	31,595	11,968	0	3,536	2,112	(1,424)	30,171	0

6.2.3. Landfill Nitrogen

As described in Section 5.5.4, model simulations shown on Figures 19 and 20 indicate that the path of the landfill nitrate plume could be influenced by a discharge at either of the Lots Hollow Road sites. Under the no discharge scenario (Simulation A, Figure 19), the model results indicate that most of the landfill plume discharges into Town Cove along the south and west side of the estuary. The model also indicates that most of the remaining plume discharges to Boat Meadow Harbor and Cape Cod Bay.

Model Simulations D and F (Figures 19 and 20, respectively) indicates that discharging at 250,000 or 500,000 gpd at 32 Lots Hollow Road the landfill plume moves to the east resulting in the plume entering Town Cove to the south and southeast.

Discharging at 32 Lots Hollow Road may result in additional nitrate from the landfill entering the Town Cove Watershed and ultimately Town Cove. The additional nitrate load would likely be relatively small compared to the nitrate load removed by the sewering of the Downtown area.

Distributing the discharge to both 32 and 43 Lots Hollow Road (Simulations I and K), the model results are similar to discharging at 32 Lots Hollow Road. The most significant difference is that the plume takes a more easterly path and enters Town Cove to the south and east.

Model scenarios simulating all of the WWTF flow discharging to 43 Lots Hollow Road (Simulations N and P) indicates that the landfill plume moves further to the east, north and west than under steady-state conditions (Simulation A). The plume appears to discharge across the Little Namskaket Creek, Rock Harbor, Boat Meadow Harbor, Meetinghouse Pond, and Cape Cod Bay watersheds. The plume that cross the Little Namskaket Creek and Rock Harbor Watershed divides flows under the estuaries, discharging directly to Cape Cod Bay. The wider distribution of the landfill plume is the result of the WWTF effluent discharging directly over the western portion of the plume.

Historic monitoring at the landfill (Section 4.3) indicates that groundwater downgradient of the landfill contains nitrogen in the forms of nitrate and ammonia. In general, the landfill plume below 43 Lots Hollow Road contains nitrate in the upper 15 to 20 feet of the aquifer. Below the nitrate, most of the groundwater nitrogen is in the form of ammonia (AECOM, 2018).

In the presence of more oxygenated water, such as a WWTF discharge, ammonia can convert to nitrate. Studies have shown that nitrate travels significantly faster through an aquifer than ammonia (Barbaro, 2013). If a significant portion of the landfill ammonia plume is converted to nitrate, the receiving watersheds could receive the converted landfill nitrogen sooner than if the nitrogen remained ammonia.

Based on the model simulations discussed in this section, discharging at 32 Lots Hollow Road would appear to have the least chance of the oxygenated WWTF discharge mixing with the ammonia from the landfill. Simulations D and F show that the particle traces representing the discharge and landfill plume are a significant distance from each other and discharge into separate watersheds. This separation indicates that the conversion of ammonia to nitrate is not likely. The 32 Lots Hollow discharge is located furthest from the plume and is located in a different watershed than the landfill. The groundwater divided between the watersheds likely contributes to this separation.

The particle traces representing a discharge at 32 and 43 Lots Hollow Road (Simulations I and K) indicate less distance between the discharge and plume particle traces increasing the likelihood of mixing and ammonia converting to nitrate. In scenarios where the groundwater discharge take place only at 43 Lots Hollow Road (Simulations N and P), the WWTF effluent discharges directly over a portion of the landfill plume moving it into several watersheds. Under this scenario the mixing of the landfill plume and the more oxygenated discharge is most likely.

As discussed in Section 4.3, ammonia exists 15 to 20 below the water table at 43 Lots Hollow Road. With the discharge taking place above the water table, the groundwater mounding would have the tendency to move the landfill plume deeper into the aquifer. Even though the discharge takes place above the water table and direct mixing may not take place below the wick, it is likely that downgradient of the discharge, mixing of the more oxygen rich discharge with ammonia may result in some ammonia converting to nitrate. The ammonia load converted to nitrate could not be estimated using the AECOM modified USGS model. Estimating the fate and transport of nitrate and ammonia would require the application of a different model.

At this time, the Town has designates 32 Lots Hollow Road as the primary discharge site. If in the future, the Town were to choose to discharge all or a portion of the WWTF effluent at 43 Lots Hollow Road, further evaluation the impact of the discharge on the landfill nitrogen load may be required.

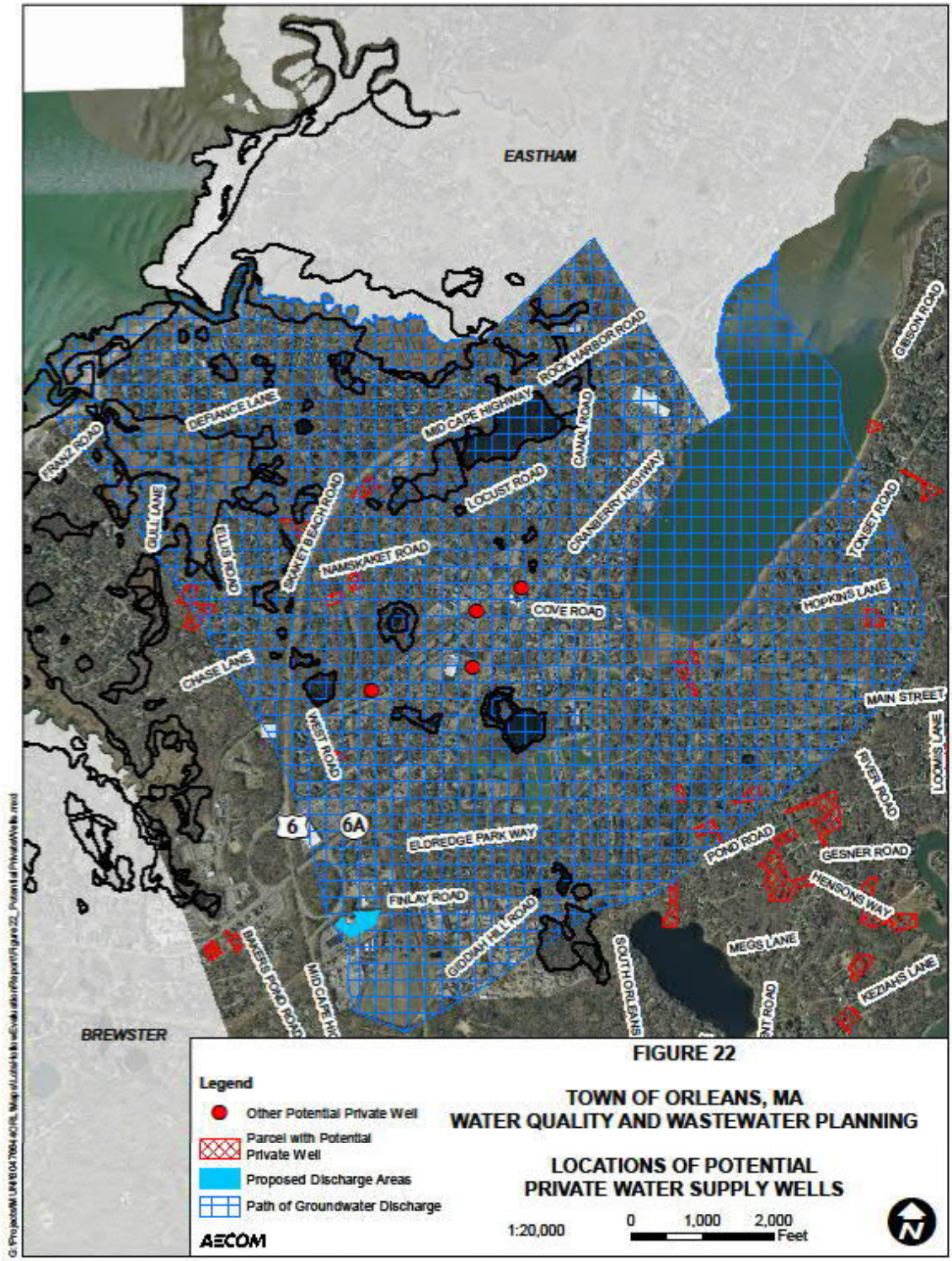
6.2.4. Private Wells

There are no known sensitive receptors directly downgradient of the discharge with the exception of potential private water supply wells. According to Town records, there are several potential private water supply wells located downgradient of the discharge. According to Town records, there are properties on Old Colony Way, West Road, Kings Road, Namskaket Way, Bevan Way, and Skaket Beach Road that may have private wells (Figure 22). If wells exist and they are used for drinking water or irrigation supply, the Town should consider offering to connecting any property to the public water supply as the well may be located within the influence of the discharge.

6.2.5. Public Water Supplies

As outlined in Section 5.5.5, Figure 21 presents simulations of the proposed groundwater discharge on the zones of contribution of the Towns of Orleans and Harwich groundwater supplies. As noted on Figure 21, the water supply wells, landfill, and the proposed discharge at 32 Lots Hollow Road are located in different watersheds. The distance between the nearest water supply well (Town of Orleans's Goulds Pond Well #2), the discharge location and the closest point of the landfill are approximately 4,400 and 2,900 feet, respectively.

The scenarios performed indicate that with a 500,000 gpd discharge and the water supply wells pumping at 2002 average rates or 2020 projected rates, that neither particle traces representing the landfill plume nor the groundwater discharge moves towards the pumping water supply wells. The proposed groundwater discharge is therefore not expected to have an impact on the groundwater supplies of Orleans or Harwich.


EASTHAM
BREWSTER
DEFIANCE LANE
FRANZ ROAD
GULL LANE
ELLIS ROAD
SKATE BEACH ROAD
NAMSKAKET ROAD
LOCUST ROAD
MID CAPE HIGHWAY
CANAL ROAD
ROCK HARBOR ROAD
CRANBERRY HIGHWAY
GIBSON ROAD
TONSET ROAD
HOPKINS LANE
COVE ROAD
CHASE LANE
WEST ROAD
MAIN STREET
LOOMIS LANE
RIVER ROAD
POND ROAD
GESNER ROAD
HENSONS WAY
ELDREDGE PARK WAY
FINLAY ROAD
GIDDAH HILL ROAD
BAKERS POND ROAD
MID CAPE HIGHWAY
SOUTH ORLEANS
MEGS LANE
KEZIAHS LANE
6
6A
FIGURE 22
Legend
Other Potential Private Well
Parcel with Potential Private Well
Proposed Discharge Areas
Path of Groundwater Discharge
TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING
LOCATIONS OF POTENTIAL PRIVATE WATER SUPPLY WELLS
1:20,000
0
1,000
2,000
Feet
AECOM

6.3. Potential Impacts to Coastal Resources

Coastal resources in the area of groundwater mounding and eventual effluent discharge include beaches and associated swimming areas, commercial and recreational shellfishing areas, and marine/estuarine habitat. The groundwater mound and effluent discharge would occur within the Inner Cape Cod Bay Area of Critical Environmental Concern (ACEC), which includes Cape Cod Bay, both Namskaket and Little Namskaket Creeks, Boat Meadow River, and Rock Harbor up to the 10-foot elevation contour. Because of the depth of effluent disposal the majority of effluent will travel beneath these coastal resources to be mixed with waters sufficiently offshore where substantial tidal flushing will occur. As discussed above, the treatment and disposal of sewage through the proposed groundwater discharge rather than the continued use of on-site septic systems is expected to result in an overall improvement to water quality which would benefit all coastal resources. Thus the discharge is not expected to adversely affect the ACEC functions.

6.4. Potential Impacts to Wetlands

As discussed above, the western extent of the simulated groundwater mound will intercept with the eastern/southeastern boundary of Namskaket Creek. The mound may result in a shift in plant composition with more freshwater species and fewer salt marsh species, with a potential expansion in extent of Phragmites in the short-term. Over a longer time frame these changes may be dwarfed as a result of sea level rise. AECOM recommends monitoring of Namskaket Creek to document the long-term plant community stability as well as any potential changes. If adverse changes are documented, compensatory mitigation should be implemented.

6.5. Potential Impacts to Rare and Endangered Species

According to the MassGIS datalayers, Cape Cod Bay, the area of Namskaket and Little Namskaket Creek marshes and adjacent streams, Rock Harbor and Town Cove are all mapped as Priority Habitat (polygon PH 945). In addition, Town Cove is also mapped as Estimated Habitat. The Massachusetts Natural Heritage and Endangered Species Program (NHESP) has not been contacted to determine which species are present in the areas of groundwater mounding and eventual effluent discharge. However, as discussed above, no adverse water quality impacts are anticipated to occur to any of these receiving waters, and therefore there are not expected to be any water quality impacts to any protected species. In addition, the groundwater effluent is not expected to reach the estuaries for approximately 100 years.

As discussed above, the proposed discharge would result in a groundwater mound that may intercept the eastern edge of Namskaket Creek. During consultation with NHESP during the preparation and submittal of the 2010 Comprehensive Wastewater Management Plan (CWMP), it was determined that Priority Habitat for four species protected under the Massachusetts Endangered Species Act (MESA) was present at the Tri-Town Septage Treatment Facility site, which is relatively close to the proposed discharge at Lots Hollow. The four species identified were: the Eastern Box Turtle (Terrapene carolina), the Diamond-backed Terrapin (Malaclemys terrapin), Salt Reedgrass (Spartina cynosuroides), and Mitchell's Sedge (Carex mitchelliana). During more recent discussions pertaining to the demolition of the compost shed associated with the Tri-Town site, MA NHESP indicated that the area west of the site was potential habitat for two state listed plant species. Thus, the predicted mound from a discharge at the Lots Hollow site may extend to areas including habitat for any of these species and potentially others.

Additional consultation with NHESP is needed to determine the species potentially present at the discharge site and mounding locations. Mitigation measures could include pre-discharge surveys to document the location of protected plant species and ongoing monitoring to evaluate any impacts on these species. However, monitoring may be necessary to confirm presence and any impacts on protected species. Salt Reedgrass occurs at the upper fringes of salt marsh, while Mitchell's sedge occurs in freshwater areas adjacent to salt marsh. These species would be particularly susceptible to changes in salinity and hydrology that may occur as a result of the groundwater mound. Thus, additional consultation with NHESP is necessary to confirm any necessary mitigation measures.

6.6. Increased Flow to Watersheds

Additional fresh-water flow to each of the estuaries is summarized in Tables 18, 23, and 28. The percentage of increased flow is also summarized in these tables. Due to the nature of marsh soils, a majority of the increased flow would likely enter the marshes through the stream channels where the greatest stream flow occurs due to tidal flux. The percentage of increased flow to the estuaries is relatively low. The estuaries with the greatest flow are tidal creeks that would discharge most of the additional freshwater with each tidal cycle. Outside the potential for groundwater mounding impacts discussed in Section 6.1, the additional freshwater flow is not expected to impact on the estuaries.

6.7. Soils near Water Tank

One of the goals of the loading test was to evaluate groundwater mounding near the wick. The loading test demonstrated that at a loading rate of 126,000 gpd (88 gpm), minimal groundwater mounding occurred across the site. At monitoring well LH-1, five feet from the wick, groundwater mounding was approximately 3.1 feet. The mound remained relatively stable over the final nineteen days of the loading test. The mound decreased with distance from the test wick. In monitoring wells located 15, 32, 60, 156, and 233 from the test wick, the maximum mound noted during the 32 days of loading was 2.85, 2.38, 2.00, 1.07, and 0.08 feet respectively.

Based on the groundwater model scenarios, test results and the groundwater model scenario, groundwater mounding at the site is expected to be no greater than 1.0, 2.8, 4.4, 5.9, and 7.9 feet at flow rates of 50,000, 150,000, 250,000, 350,000, and 500,000 gpd, respectively.

The proposed wicks will be installed a minimum of 40 feet from the water tank and foundation. A slight increase in the water table is expected below the water tank and foundation during discharge, though the fluctuation in groundwater levels will be similar to the seasonal rising and falling water table due to changes in precipitation. At the buildout discharge rate of 250,000 gpd, the water table will be an estimated four feet higher than if no discharge were taking place. However, this water table rise will be minimal compared to the over 100 feet of unsaturated soils below the tank.

During wick construction, a 3- to 6-foot diameter vertical column of artificial gravel will be installed at each wick location. A 3- to 6- foot diameter drill casing will be used to drill a borehole for the wick. Once the borehole has been drilled, the gravel pack will be installed as the casing is removed. At no time during installation will the formation be allowed to collapse into the borehole.

Once the drill casing has been removed, the gravel will support the surrounding soils with no settling of the surrounding soils expected. Construction and operation of the proposed wicks should have no impact on the water tank or surrounding infrastructure.

7. PRIMARY AND RESERVE DISCHARGE LOCATIONS

7.1. Primary Discharge Location

As previously mentioned, the Town of Orleans has selected 32 Lots Hollow as the primary discharge location and is seeking MassDEP approval to discharge 500,000 gpd at the site. The request to discharge WWTF effluent at the site will be included as part of the Groundwater Discharge Permit application. The proposed discharge area is shown on Figure 23.

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at the 32 Lots Hollow to discharge 500,000 gpd of WWTF effluent. Groundwater modeling indicates that a minimum of 500,000 gpd can be discharged at the site. The Town plans to convey and discharge all of the WWTF effluent at 32 Lots Hollow Road.

7.2. Reserve Discharge Locations

Three reserve discharge locations have been identified. The locations are 43 Lots Hollow Road, Route 6 (Exit 12), and 223 Beach Road. The reserve discharge location details are shown on Figure 23.

7.2.1. 43 Lots Hollow Road

The Hydrogeologic Evaluation for 43 Lots Hollow Road is included herein. The Town is seeking MassDEP approval for a 500,000 gpd discharge at the site. The discharge would take place within the discharge area shown on Figure 5. As with 32 Lots Hollow Road, the groundwater discharge would take place through the installation of a series of wicks.

7.2.2. Route 6 (Exit 12)

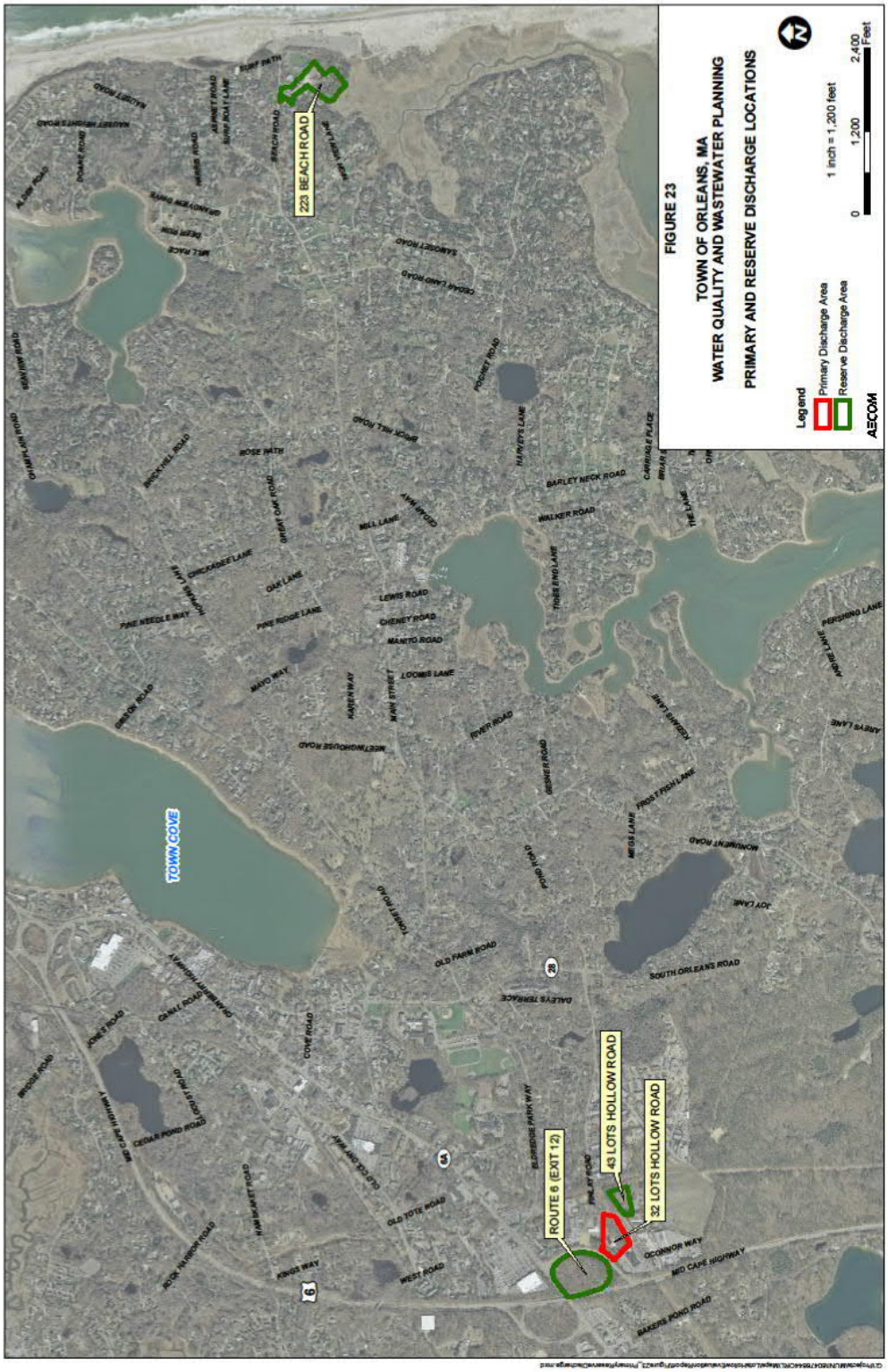
MassDEP has approved a discharge of 140,000 gpd at the Route 6, Exit 12 site. The Town has proposed a wick loading test at the site and will be submitting an updated Hydrogeologic Evaluation for the site to MassDEP requesting approval for a wick discharge be allowed at the site. The site is controlled by MassDOT. The Town of Orleans and MassDOT are working on an agreement to allow the Town to use the site for a groundwater discharge.

7.2.3. 223 Beach Road

AECOM completed a Hydrogeologic Evaluation for 223 Beach Road in June 2016. In February 2017, MassDEP approved 223 Beach Road for a 200,000 gpd discharge through subsurface leaching trenches. A copy of the approval letter is provided in Appendix A.

The Hydrogeologic Evaluation concluded that 223 Beach Road site is suitable for a groundwater discharge greater than 200,000 gpd. However, the approved discharge was based on a discharge rate where all of the WWTF discharge would flow directly to the Atlantic Ocean without no flow, and associated nitrate load, going to a nitrate impacted estuary. As part of the 2016 Hydrogeologic Evaluation, groundwater model scenarios indicated that at discharge rates greater than 200,000 gpd, a portion of the WWTF discharge may flow into the Pochet River, a subwatershed of the nitrate impacted Pleasant Bay Watershed.

If the Town planned to discharge at 223 Beach Road at a rate greater than the approved 200,000 gpd, additional nitrate reduction measures within the Pleasant Bay Watershed may be required by MassDEP. The purpose of the nitrate reduction measures would be to offset the additional WWTF nitrate load to the Pochet River subwatershed. Prior to increasing the discharge over 200,000 gpd, the Town would be required to submit a request to MassDEP for the proposed discharge rate. At a minimum, the request would need to include the anticipated discharge rate at the site, an estimate of the nitrate load from the WWTF discharge to the Pochet River subwatershed, and supporting documentation.


FIGURE 23
TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING
PRIMARY AND RESERVE DISCHARGE LOCATIONS
Legend
Primary Discharge Area
Reserve Discharge Area
1 inch = 1,200 feet
0
1,200
2,400
Feet
AECOM
223 BEACH ROAD
43 LOTS HOLLOW ROAD
32 LOTS HOLLOW ROAD
ROUTE 6 (EXIT 12)
TOWN COVE
BARLEY NECK ROAD
WALKER ROAD
LEWIS ROAD
CHENEY ROAD
MANTO ROAD
LOOMIS LANE
MAYO WAY
MAIN STREET
RIVER ROAD
GIBNEY ROAD
POND ROAD
OLD FARM ROAD
SOUTH ORLEANS ROAD
COVE ROAD
OLD TOTE ROAD
WEST ROAD
MID CAPE HIGHWAY
O'CONNOR WAY
BAKERS POND ROAD
PILOT ROAD
BEACH ROAD
SURF PATH
SUNSET HEIGHTS ROAD
HARRIS ROAD
JERNET ROAD
SUNSET ROAD
CEDAR LAND ROAD
POCKET ROAD
HARVEYS LANE
CARRIAGE PLACE
BRICK HILL ROAD
ROSE PATH
GREAT OAK ROAD
MILL LANE
CHICKADEE LANE
OAK LANE
PINE RIDGE LANE
PINE NEEDLE WAY
THREE PENCE LANE
MEETINGHOUSE ROAD
HARRIS WAY
TOWER ROAD
FROST FISH LANE
MONUMENT ROAD
JOY LANE
PERSHING LANE
ARETE'S LANE
DALEY'S TERRACE
BLUEBERRY PARK WAY
QUARRY CREST WAY
HARBOR VIEW ROAD
KINGS WAY
JACK HARBOR ROAD
CEDAR POND ROAD
BRIDGE ROAD
JONES ROAD
GIBNEY FARM ROAD
OLD COLONY HIGHWAY

8. GROUNDWATER DISCHARGE – 32 LOTS HOLLOW ROAD

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at 32 Lots Hollow Road to discharge upto 500,000 gpd or WWTF effluent. The estimated number of wicks, preliminary wick design, and proposed discharge areas are discussed in the following sections.

8.1. Preliminary Wick Design and Capacity

The proposed wick is essentially a column of gravel that is installed vertically from the ground surface through the unsaturated portion of the aquifer to a specified depth above the water table. Once online, effluent from the WWTF will be conveyed from the WWTF and discharged over the gravel at the surface of the wick. Once discharged, the effluent will flow downward through the gravel in the wick, discharging outward into the aquifer. This will first occur at the base of the wick or once the discharge reaches the temporary mound created by effluent discharging into the aquifer for the WWTF.

Based on the site soils, depth to water table, and wick loading test results, it is expected that a full scale wick would range in diameter between three and six feet. The total depth of the wick would be between 50 and 100 feet. The final wick design including the diameter, total depth, gravel selection, etc. will be included as part of the GWDP application. Wick operations and maintenance (O&M) will also be proposed as part of the application.

As discussed in Section 4.5, the capacity of each wick is expected to be in excess of 500,000 gpd. It is anticipated that three to four wicks will be installed within the discharge area at 32 Lots Hollow Road (Figure 4). The number of wicks installed will allow for redundancy in the discharge capacity and for proper operation and maintenance of the wicks.

8.2. Preliminary Wick Locations

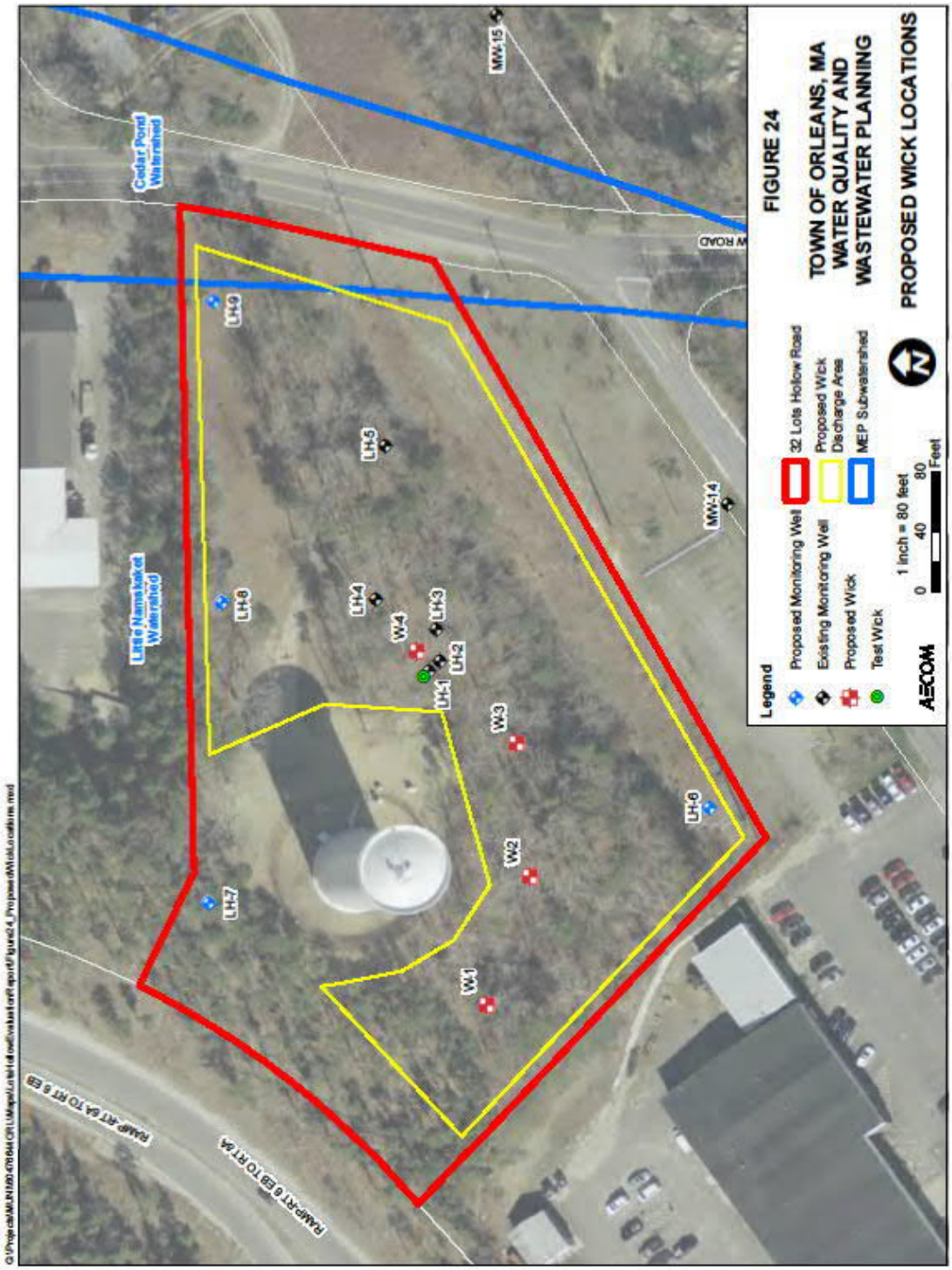
Preliminary wick locations are shown on Figure 24. These locations may be adjusted based on discussion with the Town, Water Department and site conditions. The final locations will be submitted with the final wick design as part of the GWDP application.

At this time, the wicks are proposed to be installed on the western portion of the discharge area. This is primarily due to overhead utilities and topography. Installing the wicks in the western portion of the discharge area will have the added benefit of providing additional separation between the discharge and the landfill plume. The discharge locations will also be further west of the groundwater divide for Town Cove which should decrease the amount of effluent nitrate that flows into the Town Cove Watershed.

8.3. Groundwater Monitoring Plan

A groundwater monitoring plan will be implemented to assess both baseline and compliance groundwater quality in the vicinity of the proposed discharge. The number and location of the compliance monitoring wells will be based on the final wick locations. Preliminary monitoring locations (LH-6, LH-7, LH-8, LH-9, and MW-14) are shown on Figure 24. A detailed compliance monitoring plan will be submitted as part of the GWDP application.

Prior to discharging, two rounds of groundwater samples will be collected at the compliance monitoring wells and sent to a laboratory for analysis. As required by MassDEP, water samples will be analyzed in the field for temperature, pH and specific conductance. Groundwater samples collected from each of the monitoring wells will also be sent to a MassDEP certified laboratory for analysis. At a minimum, laboratory analysis will include nitrate-nitrogen, total nitrogen, total phosphorus, sodium, and volatile organic compounds (VOCs). Groundwater sampling will be conducted in accordance with MassDEP guidance. A round of water levels will also be collected during each round of sampling. The water level data and water quality results will be submitted to the MassDEP for review.


FIGURE 24
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
PROPOSED WICK LOCATIONS
Legend
Proposed Monitoring Well
Existing Monitoring Well
Proposed Wick
Test Wick
32 Lots Hollow Road
Proposed Wick Discharge Area
MEP Subwatershed
1 inch = 80 feet
0
40
80
Feet
AECOM
N
Cedar Pond Watershed
Little Namskaket Watershed
MW-15
MW-14
LH-9
LH-8
LH-7
LH-6
LH-5
LH-4
LH-3
LH-2
LH-1
W-4
W-3
W-2
W-1
RAMP-RT 6A TO RT 6 EB
RAMP-RT 6 EB TO RT 6A

Once the WWTF is operational, samples from the compliance monitoring wells will be collected and analyzed to demonstrate that the groundwater quality meets the standards specified by MassDEP. Groundwater sampling and water level monitoring will be performed at the locations, frequency, and for the parameters stipulated in the GWDP.

Groundwater samples collected during each sampling round will be sent to a MassDEP certified laboratory for analysis. Groundwater sampling will be conducted in accordance with MassDEP's guidelines. After each round of sampling, the water level data and water quality results will submitted to the MassDEP for review.

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9. REFERENCES

Anderson, M.P. and W.W. Woessner, 1992, Applied Groundwater Modeling, Academic Press, Inc., San Diego, California.

Barbaro, J.R., Walter, D.A., and LaBlanc, D.R., 2013, Transport of Nitrogen in a Treated-Wastewater Plume to Coastal Discharge Areas, Ascumet Valley, Cape Cod, Massachusetts", USGS, Scientific Investigations Report 2013-5067.

Carman, 1937, "Fluid flow through granular beds." Transactions, Institution of Chemical Engineers, London, 15: 150-166,

Carman, 1956. "Flow of gases through porous media." Butterworths, London.

Coastal Engineering Co. Inc, 1992, the Initial Site Assessment Report Orleans Municipal Sanitary Landfill.

Coastal Engineering Co. Inc, 1992, Supporting Documentation for Septage Lagoon Closure.

Coastal Engineering Co., Inc., 1999, Comprehensive Site Assessment Report Orleans Municipal Sanitary Landfill.

Frimpter, M.H., 1980, "Probable High Ground-Water Levels in Massachusetts," U.S. Geological Survey Water Resource Investigations 80-1205.

Guswa, J.H., and LeBlanc, D.R., 1985, Digital models of ground-water flow in the Cape Cod aquifer system, Massachusetts: U.S. Geological Survey Water-Supply Paper 2209, 112 p

Hazen, A., 1892, Experiments upon the Purification of Sewage and Water at the Lawrence Experiment Station, Massachusetts State Board of Health 23rd Annual Report.

Howes B.L., S.W. Kelley, J.S. Ramsey, R.I. Samimy, E.M. Eichner, D.R. Schlezinger, 2007a. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Namskaket Marsh Estuarine System, Orleans, MA. SMAST/DEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

Howes B.L., E.M. Eichner, S.W. Kelley, J.S. Ramsey, R.I. Samimy, D.R. Schlezinger 2007b. Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Little Namskaket Marsh Estuarine System, Orleans, MA. SMAST/DEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

Howes B.L., S.W. Kelley, J.S. Ramsey, R.I. Samimy, D.R. Schlezinger, E.M. Eichner (2007c). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Rock Harbor Embayment System, Orleans, MA. SMAST/DEP Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA.

Howes B., S. Kelley, J.S. Ramsey, E. Eichner, R. Samimy, D. Schlezinger, P. Detjens (2012). Massachusetts Estuaries Project Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, Massachusetts, Massachusetts Department of Environmental Protection. Boston, MA.

Koteff, C., and Cotton, J.E., 1962, Preliminary Results of Recent Deep Drilling on Cape Cod Massachusetts, Science, v. 137, no. 2523, p. 34.

Kozeny, J., 1927, "Ueber kapillare Leitung des Wassers im Boden." Sitzungsber Akad. Wiss., Wien, 136(2a): 271-306.

McDonald, M.G. and A.W. Harbaugh, 1988, "A Modular Three-Dimensional Finite Difference Groundwater Flow Model", Techniques of Water Resources Investigations 06-Al, USGS.

Oldale, R. N., Carl Koteff, and J. H. Hartshorn, 1971, Geologic Map of the Orleans Quadrangle, Barnstable County, Cape Cod, Massachusetts", GQ-931, U. S. Geological Survey.

Odong, Justine, 2007, Evaluation of Empirical Formulae for Determination of Hydraulic Conductivity based on Grain-Size Analysis, Journal of American Science, 3(3).

Poeter, E.P and M.C. Hill, 1998, "Documentation of UCODE, A Computer Code for Universal Inverse Modeling," U.S. Geological Survey Water Resources Investigations Report 98-4080.

Pollock, D.W., 1994, User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 94-464, 234 p.

Randall, A.D., 1996, "Mean Annual Runoff, Precipitation and Evapotranspiration in the Glaciated Northeastern United States, 1951-1980," U.S. Geological Survey, Open File Report, OFR 96-395.

Shepherd, R.G. 1989, Correlations of permeability and grain size. Ground Water 27 (5), 633-638.

Salarashayeri, A. F., and Siosemarde, M., 2012, Prediction of Soil Hydraulic Conductivity for Particle-Size Distribution", International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering, Vol. 6, No. 1.

Wang, T., Huang, Y. Chen, X., and Chen, X., February 2015, Using Grainsize Distribution Methods for Estimation of Air Permeability, Groundwater, NGWA Press, 1 – 12 p.

Woodworth, J. B. and Wigglesworth, Edward, 1934, Geography and Geology of the Region including Cape Cod, the Elizabeth Islands, Nantucket, Martha's Vineyard, No Mans Land, and Block Island: Harvard Coll. Mus. Comp. Zoology Mem. v.52, 322 p.

University of Massachusetts Dartmouth, School of Marine and Science Technology (SMAST), 2016. Stability of Wetland Plant Communities in Upper Namskaket Marsh, Town of Orleans, Massachusetts. Dr. Brian Howes and Paul Mancuso. January 2016.

US Geological Survey (USGS), 2016. Walter, D.A., McCobb, T.D., Masterson, J.P. and Fienen, M.N. Potential effects of sea-level rise on the depth to saturated sediments of the Sagamore and Monomoy flow lenses on Cape Cod, Massachusetts (ver. 1.1, October 12, 2016). USGS Scientific Investigation Report 2016-5058, 55 p. http://dx.doi.org/10.3133/sir20165058

Appendix A

Correspondence

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PUBLIC NOTICE

NOTICE OF HYDROGEOLOGIC EVALUATION

SCOPE OF WORK

PURSUANT TO 314 CMR 5.09(1)(b)

Downtown Area WWTF Discharge - Town or Orleans

Pursuant to 314 CMR 5.09(1)(b), public notice is hereby given that a Scope of Work for a Hydrogeologic Evaluation has been prepared and will be submitted to the Massachusetts Department of Environmental Protection at it's Southeast Regional Office, 20 Riverside Drive, Lakeville, MA 02347. The Scope of Work was prepared on behalf of the Town of Orleans in support of a future Groundwater Discharge Permit to regulate proposed wastewater infrastructure for "Downtown Area" of Orleans.

Additional information regarding the Scope of Work may be obtained by contacting Mark Owen or Tom Parece from AECOM (9 Jonathan Bourne Drive, Pocasset, MA) at 978-905-2100; (mark.owen@aecom.com), Tom.Parece@AECOM.com.

Welcome to the *Environmental Monitor* page. In order to access previous issues of the *Environmental Monitor* published since the launch of the new MEPA website on September 23, 2009, please select the year and publication date from the following drop-down lists.

In order to access issues of the *Environmental Monitor* published from 2002 through September 9, 2009, please click on the Environmental Monitor Archives link.

Select Year: 2018 ▼
Select Publication Date: 01/24/2018 ▼

Back Environmental Monitor Archives

MEPA Environmental Monitor

Jan 24, 2018
Volume 89, Issue 06

The Environmental Monitor
a publication of the
Massachusetts Executive Office of Energy and Environmental Affairs
Charlie Baker, Governor
William F. Galvin, Secretary

The Environmental Monitor provides information on projects under review by the Massachusetts Environmental Policy Act (MEPA) office, recent MEPA decisions of the Secretary of Energy & Environmental Affairs, and public notices from environmental agencies. Please note that the links on this page require the use of Adobe Acrobat Reader®, which is available free of charge at http://www.adobe.com/products/acrobat/readstep.html.

Projects Submitted Jan 3,2018 - Jan 16,2018
- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change

Secretary's Certificates Jan 3,2018 - Jan 16,2018
- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change
- Records of Decision

Other Projects Under Review
- Environmental Notification Forms
- Environmental Impact Reports
- Notices of Project Change

Requests for Advisory Opinion

Public Notices
- Submitting Public Notices

Site Visits

Projects Submitted Jan 3,2018 - Jan 16,2018

Environmental Notification Forms

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
15794	Mass Audubon/Wachusett Meadow Wildlife Pond Accessible Trail	Princeton	02/13/2017	Cindy Dunn (978) 464-2712	Eve Schluter (617) 626-1131
15796	The Preserve at Abbyville and Abbyville Commons	Norfolk	02/13/2018	Mary Ellen Radovanic (617) 896-4506	Erin Flaherty (617) 626-1128
15797	Squantum Point Pier & Ferry Dock Improvements Project	Quincy	Withdrawn	Tracy Adamski (413) 572-3256	Page Czepiga (617) 626-1021
15798	White Cap Shoreline Stabilization Project	Sandwich	02/13/2018	Jack Vaccaro (978) 897-7100	Erin Flaherty (617) 626-1128
15799	Fairfield Commons Development	Somerset	03/13/2018	Joseph Freeman (781) 255-1982	Page Czepiga (617) 626-1021

Environmental Notification Forms - Site Visits

EEA No.	Date	Time	Location
15794	02/02/2016	10:00 AM	Meet at Crocker House mtg. rm.@ Wachusett Meadow Sanctuary, 113 Goodnow Rd., Princeton
15796	02/02/2018	10:00 AM	Meet at Norfolk Public Library, 139 Main St., Norfolk - Follow by Site Visit
15798	02/01/2018	1:00 PM	Meet at end of White Cap Path, Sandwich
15799	02/06//201	10:00 AM	Meet at Somerset Public Library (Large meeting room 1st flr.) 1464 County St. (adjacent to Town Hall) somerset

Environmental Impact Reports

EEA No.	Project Name	Location	Document Type	Comments Due	For Copies	MEPA Analyst
15273	Eastham Water System - Phase 2	Eastham	Supplemental Draft Environmental Impact Report	02/23/2018	Mark White (617) 657-0200	Purvi Patel (617) 626-1029

Notices of Project Change

No Data Found.

Other Projects Under Review

Environmental Notification Forms

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
15783	Suffolk Downs Redevelopment	Boston and Revere	01/19/2018	Lauren DeVoe (617) 607-0091	Page Czepiga (617) 626-1021
15787	Vineyard Wind Connector	Barnstable	01/30/2018	Holly Carlson (978) 897-7100	Purvi Patel (617) 626-1029
15788	Conveyance of Tenean St. Parcel to Sullivan McLaughlin Companies Inc.	Boston (Dorchester)	01/19/2018	Michael Brodigan (617) 542-1871	Anne Canaday (617) 626-1035
15789	Fairhaven Development	Fairhaven	01/30/2018	Colleen Medeiros (508) 823-2245	Purvi Patel (617) 626-1029
15792	S&J Exco-MSW Facility Expansion	Dennis	01/30/2018	Gregory Wirsen (508) 888-6034	Erin Flaherty (617) 626-1128
15793	Northeastern University MSC Seawater Intake	Nahant	WITHDRAWN	Briscoe Lang	Alex Strysky (617)

	Replacement			(401) 334-4100	626-1025
15794	Mass Audubon/Wachusett Meadow Wildlife Pond Accessible Trail	Princeton	02/13/2018	Cindy Dunn (978) 464-2712	Eve Schluter (617) 626 1131
15795	Middle Pond Beach Maintenance Project	Taunton	WITHDRAWN	Alex Patterson (401) 330-1233	Purvi Patel (617) 626-1029

Environmental Impact Reports

EEA No.	Project Name	Location	Document Type	Comments Due	For Copies	MEPA Analyst
11202	MassDot Snow and Ice Control	Statewide	Final Environmental Impact Report	02/23/2018	Laurene Poland (857) 368-8821	Alex Strysky (617) 626-1025
15278	I-90 Allston Interchange Project	Boston	Draft Environmental Impact Report	02/9/2018	James Cerbone (857) 368-8792	Alex Strysky (617) 626-1025
15610	115 Winthrop Square	Boston	Draft Environmental Impact Report	02/09/2018	Corrine Snowdon (978) 897-7100	Page Czepiga (617) 626-1021

Notices of Project Change

EEA No.	Project Name	Location	Comments Due	For Copies	MEPA Analyst
13897	EIR & CWMP/Main Lift Pumping Station Improvements	Taunton	01/30/2018	Michael Andrus (401) 333-2382	Page Czepiga (617) 626-1021

Secretary's Certificates Jan 3,2018 - Jan 16,2018

Environmental Notification Forms

EEA No.	Project Name	Location	Action	Action Date
15781	Milford Power	Milford	Does not Require an Environmental Impact Report	01/05/2018
15784	Snow Fields Estates	Mattapoisett	Does not Require an Environmental Impact Report	01/05/2018
15785	Fames Mill Pond Dam Repair Project	Paxton	Requires a Mandatory Environmental Impact Report	01/12/2018
15786	Lowell Area Gas Modernization Project	Lowell, Chelmsford and Tewksbury	Requires an Environmental Impact Report	01/05/2018
15790	Masconomo Park and Morss Pier Improvements	Manchester - By-The-Sea	Does not Require an Environmental Impact Report	01/19/2018
15791	Reconstruction of Main Street (Route 30)	Southborough	Does not Require an Environmental Impact Report	01/19/2018

Environmental Impact Reports

EEA No.	Project Name	Location	Document Type	Action	Action Date
15355	Route 20 Reconstruction Project	Charlton and Oxford	Draft Environmental Impact Report	Adequately and Properly complies	01/12/2018

Notices of Project Change

EEA No.	Project Name	Location	Action	Action Date
11333	Bourne Intergrated Solid Waste Management Facility	Bourne	Requires a Mandatory Environmental Impact Report	01/12/2018
15745	Cochituate State Park Boat Ramp	Natick	Does not Require an Environmental Impact Report	01/05/2018
4959	Lakeshore Center	Bridgewater and Raynham	Does not Require a Supplemental Environmental Impact Report	01/19/2018
8161	Boston Marine Industrial Park Master Plan /a.k.a Raymond L.Flynn Marine	Boston	Adequately and properly complies	01/19/2018

Records of Decision

EEA No.	Project Name	Location	Comments Due	Action	Action Date
15771	Field Pond Dam and Dike Rehabilitation	Andover	01/30/2018	Propose to Grant a Waiver	11/29/2017

Special Review Procedures

No Data Found.

Public Benefits Determinations

EEA No.	Project Name	Location	Action	Action Date
15575	254-272 and 282R Lynnway	Lynn	Determined to have public benefit	01/19/2018

Advisory Opinions

No Data Found.

Requests for Advisory Opinion

No Data Found.

Public Notices

Agency	Notice Type	Location
Ashburnham Conservation Commission	Notice of Intent to Initiate an Aquatic Management Program for Billy Ward Pond	Ashburnham
CZM	Notice of Extension of the City of Boston's Consultation Session for the Downtown Waterfront District Municipal Harbor Plan	Boston Harbor
CZM	Notice of Federal Consistency Reviews	Boston, Dennis and Yarmouth
DCAMM	Notice of Public Hearing on Reuse Restrictions for Sale of Land	Medford
DEP	Notice of Scope of Work for a Hydrogeological Evaluation	Orleans
DEP	Notice of Application for a Combined Chapter 91 and 401 Water Quality Certification for the Bass River Marina	Dennis
DEP	Notice of Application for a Combined Chapter 91 and 401 Water Quality Certification for Eversource Energy	Boston
DEP	Notice of Application and Draft Groundwater Discharge Permit	Norton
DEP	Notice of Application and Wastewater Management Program	Statewide
DEP	Notice of a Draft Scope of Work and Public Meeting for Preparation of a Resource Management Plan	Brockton
Groveland	Notice of Intent to Initiate an Ecological Restoration Project for Johnson's Pond	Groveland

Conservation Commission		
MDAR	Notice of Public Hearing for Vegetation Management Plan and Yearly Operational Plan	Eastern and Southeastern MA.
MDAR	Notice of Submission of a (YOP) Yearly Operational Plan	Western MA
MDAR	Notice of Public Hearing for Vegetation Management Plan and Yearly Operational Plan	Cape Cod and Martha's Vineyard
MDAR	Notice of Submission of a (YOP) Yearly Operational Plan	Wilmington
Needham Conservation Commission	Notice of Intent to Initiate an Aquatic Plant Management Program for Forbes Pond	Needham
Yarmouth Conservation Commission	Notice of Intent to Initiate an Ecological Restoration Project	Yarmouth
Yarmouth Conservation Commission	Notice of Intent to Initiate an Aquatic Management Program for Perera Pond	Yarmouth

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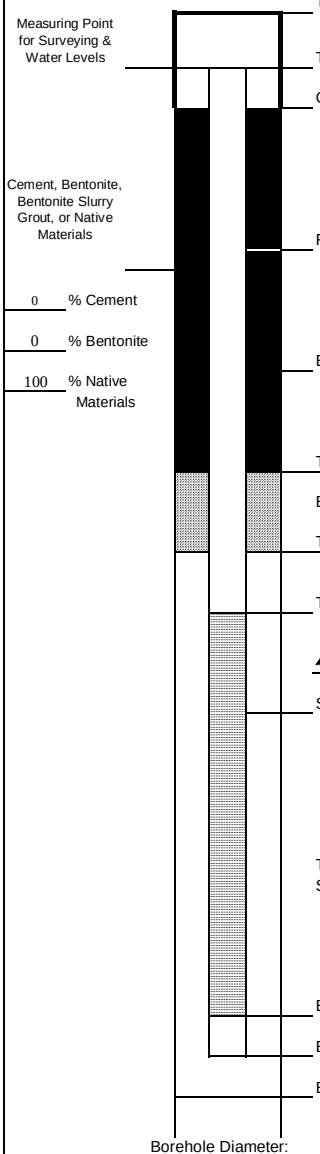
Appendix B

Soil Boring, Monitoring Well and Wick Logs

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AECOM	Client: Town of Orleans	**WELL ID: LH-1**
	Project Number: 60476644	
	Site Location: Orleans, MA	Date Installed: 01/03/2018
	Well Location: 32 Lots Hollow Coords:	Inspector: Erika Amir-Lin
	Method: CME truck mounted hollow-stem auger	Contractor: Desmond Drilling

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet)
Top of Steel Guard Pipe	+3	
Top of Riser Pipe		
Ground Surface (G.S.)	0.0	
Riser Pipe: Length 118; Inside Diameter (ID) 2-inch; Type of Material PVC		
Bottom of Steel Guard Pipe	2	
Top of Bentonite	114	
Bentonite Seal Thickness 2 feet		
Top of Sand	N/A	
Top of Screen	118	
▲ Stabilized Water Level	109	
Screen: Length 10; Inside Diameter (ID) 2 inch; Slot Size 0.01; Type of Material PVC		
Type/Size of Sand Natural Pack; Sand Pack Thickness N/A		
Bottom of Screen	128	
Bottom of Tail Pipe:	N/A	
Bottom of Borehole	128	

Borehole Diameter: 6-inch

Approved: _____ (Signature) _____ (Date)

Describe Measuring Point:

Top of PVC.

Project Number: 60476644 *Client:* City of Orleans Orleans, MA *Site Location:* 32 Lots Hollow Road; Water Tower Orleans, MA	AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100	***Boring Log LH-2*** *Boring Number:* **2** *Sheet:* 1 of 4 *Surface Elevation (ft-asl):* *Equipment:* CME *Inside Diameter:*

Well Data

Boring Depth: 129 feet
Screen Depth: 119-129 feet
Screen length: 10 feet
Water Level: ~107 feet

Project Manager: M. Owen | *Field Tech:* E. Amir-Lin | *Date Started:* 12/13/2017
Drilling Contractor: Desmond | *Driller:* Tommy/Josh | *Date Completed:* 12/22/2017

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
1									Well completed with 3 foot metal standpipe and concrete pad				1
2						27	dry	2" Dark brown loam/topsoil 3" Grey M SAND, little C sand, trace F sand. 22" Dark tan M SAND, little F sand, trace C sand.					2
3													3
4													4
5						47	dry	24" Tan F SAND, little M sand, trace C sand. 23" Light tan M SAND, some F sand, trace C sand.					5
6													6
7													7
8													8
9						26	dry	15" Tan M SAND, little F sand, trace C sand. 6" Brown F SAND. 5" Tan M SAND, little F sand, trace C sand.					9
10													10
11													11
12													12
13						41	moist	41" Orange-tan M SAND, little F sand, little C sand.	Schedule 40 PVC riser to surface Natural formation pack				13
14													14
15													15
16													16
17		No Blow Counts Collected - Drilled Direct Push to 88 feet				40	moist	Same as above; increasingly orange/Fe stained.					17
18													18
19													19
20													20
21						32	moist	28" Tan M SAND, little F sand, trace C sand. 4" Orange M SAND, little F sand, trace C sand.					21
22													22
23													23
24													24
25						26	moist	26" Light tan-buff M SAND, little C sand, trace F sand.					25
26													26
27													27
28													28
29						37	moist	16" Tan/brown mottled M SAND, occasional stringers of dark brown, F sand. 21" Tan-orange C SAND, little M sand, trace F sand.					29
30													30
31													31
32													32
33													33

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644 *Client:* City of Orleans Orleans, MA *Site Location:* 32 Lots Hollow Road; Water Tower Orleans, MA	AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100	***Boring Log LH-2*** *Boring Number:* **2** *Sheet:* 1 of 4 *Surface Elevation (ft-asl):* *Equipment:* CME *Inside Diameter:*
		Well Data Boring Depth: 129 feet Screen Depth: 119-129 feet Screen length: 10 feet Water Level: ~107 feet
Project Manager: M. Owen	*Field Tech:* E. Amir-Lin	*Date Started:* 12/13/2017
Drilling Contractor: Desmond	*Driller:* Tommy/Josh	*Date Completed:* 12/22/2017

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
34		No Blow Counts Collected - Drilled Direct Push to 88 feet				41	moist	41" Tan M SAND, little F sand, trace C sand.	Schedule 40 PVC riser to surface Natural formation pack				34
35													35
36													36
37													37
38						42	moist	42" Tan M SAND, little F sand, one 2" piece of subrounded C gravel.					38
39													39
40													40
41													41
42						37	moist	26" Tan M and C SAND, little F sand, trace F subrounded gravel.					42
43								11" Tan M SAND, some F sand, trace C sand.					43
44													44
45													45
46						36	moist	36" Light brown M SAND, clean.					46
47													47
48													48
49						36	moist	6" Orange-brown M SAND, some C sand, little F sand, trace F rounded gravel.					49
50								30" Tan M SAND, little F sand, coarse lens at 50.5 feet,					50
51								at 50 feet a lens of F rounded gravel.					51
52													52
53													53
54						36	moist	8" Tan M SAND, some C sand, little F sand, trace F gravel.					54
55								2" Brown/grey mottled SILT.					55
56								26" Tan F SAND, one lens F gravel/C sand.					56
57													57
58						48	moist	14" Orange-tan-brown C SAND, little M sand, little F sand,					58
59								little F subrounded to subangular gravel.					59
60								34" Tan F SAND, clean.					60
61													61
62						37	moist	8" Orange/tan mottled M SAND, some C sand, little F sand,					62
63								trace F subrounded gravel.					63
64								23" Tan/orange mottled M SAND.					64
65						39	moist	6" Tan F SAND, clean.					65
66								39" Tan F SAND, clean. Orange to dark brown lens at 65.5 feet.					66

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644
Client:
City of Orleans
Orleans, MA
Site Location:
32 Lots Hollow Road; Water Tower
Orleans, MA

Project Manager: M. Owen
Drilling Contractor: Desmond

Field Tech: E. Amir-Lin
Driller: Tommy/Josh

Date Started: 12/13/2017
Date Completed: 12/22/2017

AECOM
250 Apollo Drive
Chelmsford, Massachusetts
(978) 905-2100

Boring Log LH-2

Boring Number: **2**
Sheet: 1 of 4
Surface Elevation (ft-asl):
Equipment: CME
Inside Diameter:

Well Data

Boring Depth: 129 feet
Screen Depth: 119-129 feet
Screen length: 10 feet
Water Level: ~107 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
67													67
68						29	moist	29" Tan-light brown F SAND. Orange mottling. Two lenses of brown SILT, 2" thick each, at 71 and 72 feet.					68
69													69
70													70
71													71
72						31	moist	6" Light brown F SAND. 25" Tan M SAND, slight Fe stain and mottling.					72
73													73
74													74
75													75
76						42	moist	42 " Tan M SAND, trace F sand. Orange Fe mottling.	Schedule 40 PVC riser to surface Natural formation pack				76
77													77
78													78
79													79
80						47	moist	47" Light brown M SAND, little F sand.					80
81													81
82													82
83		No Blow Counts Collected - Drilled Direct Push to 88 feet, then downhole hammer employed											83
84						41	moist	Same as above.					84
85													85
86													86
87													87
88						12		12" Tan-buff M SAND, some F sand.					88
89													89
90						15		15" Buff F SAND, clean.					90
91													91
92						19		19" Tan F SAND, clean.					92
93													93
94						22		22" Tan F SAND, clean.					94
95													95
96						21		16" Tan F SAND, clean, slight Fe mottling. 5" Buff M SAND, little F sand.					96
97													97
98						22	moist	22" Tan F SAND, little M sand, slight Fe mottling.					98
99													99

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644
Client:
City of Orleans
Orleans, MA
Site Location:
32 Lots Hollow Road; Water Tower
Orleans, MA

AECOM
250 Apollo Drive
Chelmsford, Massachusetts
(978) 905-2100

Boring Log LH-2

Boring Number: **2**
Sheet: 1 of 4
Surface Elevation (ft-asl):
Equipment: CME
Inside Diameter:

Project Manager: M. Owen
Drilling Contractor: Desmond
Field Tech: E. Amir-Lin
Driller: Tommy/Josh
Date Started: 12/13/2017
Date Completed: 12/22/2017

Well Data

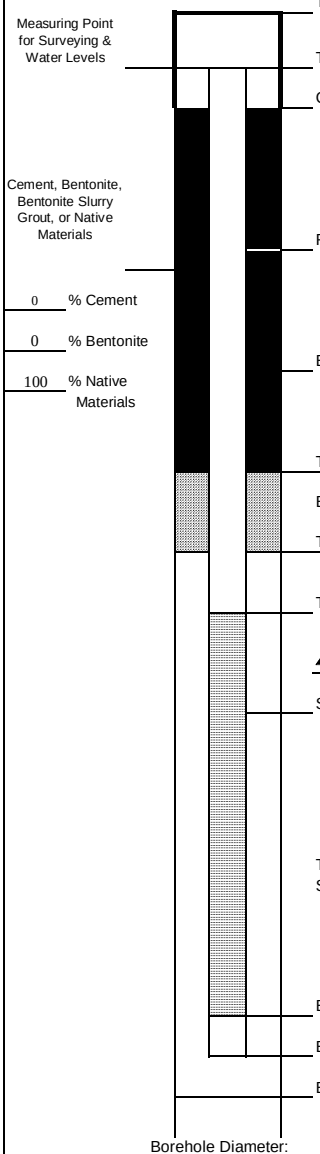
Boring Depth: 129 feet
Screen Depth: 119-129 feet
Screen length: 10 feet
Water Level: ~107 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
100						22	moist	19" Light brown F SAND, little M sand. 3" Grey SILT, trace clay, little F-M sand.	Schedule 40 PVC riser to surface Natural formation pack				100
101													101
102						19	moist	19" Tan-light brown F SAND.					102
103													103
104						18	moist	11" Light brown F SAND. 4" Brown SILTY SAND, F sand. 3" Grey/brown mottled SILT, medium stiff.					104
105													105
106						24	moist-wet	3" Same as above; SILT. 21" Brown F SAND, some silt.					106
107													107
108						24	wet	24" Brown F SAND, little silt, Fe mottling, stiff.					108
109													109
110						18	wet	18" Brown F and M SAND, Fe staining, dense.					110
111													111
112						22	wet	22" Brown F and M SAND, dense.	Time-release bentonite chip seal.				112
113		No Blow Counts Collected - Drilled Direct Push to 88 feet, then downhole hammer employed											113
114						18	wet	18" Brown F and M SAND, micaceous, dense.					114
115													115
116						17	wet	17" Brown M SAND, some F sand, lenses of reddish-brown M sand, dense.					116
117													117
118						14	wet	14" Brown M and F SAND, dense.					118
119													119
120						24	wet	25" Brown M SAND, little F sand, dense. 2" lens grey/brown mottled SILT at 121.5 feet.					120
121													121
122						24	wet	24" Brown M SAND, little F sand, dense.					122
123													123
124						21	wet	18" Brown M SAND, little F sand, dense. 3" Grey/brown mottled SILT, little clay, stiff.	.010 slot PVC screen				124
125													125
126						24	wet	Brown M SAND, little F sand, dense.					126
127													127
128													128
129						**Bottom of Boring at 129 feet**								129
130													130
131													131
132													132

Notes: F=Fine, M=Medium, C=Coarse

AECOM	Client: Town of Orleans	**WELL ID: LH-3**
	Project Number: 60476644	
	Site Location: Orleans, MA	Date Installed: 02/06/2018
	Well Location: 32 Lots Hollow Coords:	Inspector: Erika Amir-Lin
	Method: CME truck mounted hollow-stem auger	Contractor: Desmond Drilling

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet)
Top of Steel Guard Pipe	+3	
Top of Riser Pipe		
Ground Surface (G.S.)	0.0	
Riser Pipe: Length 119; Inside Diameter (ID) 2-inch; Type of Material PVC		
Bottom of Steel Guard Pipe	2	
Top of Bentonite	114	
Bentonite Seal Thickness 2 feet		
Top of Sand	N/A	
Top of Screen	119.0	
▲ Stabilized Water Level	104	
Screen: Length 10; Inside Diameter (ID) 2-inch; Slot Size 0.01; Type of Material PVC		
Type/Size of Sand native pack; Sand Pack Thickness N/A		
Bottom of Screen	129	
Bottom of Tail Pipe:	N/A	
Bottom of Borehole	129	

Borehole Diameter: 6-inch

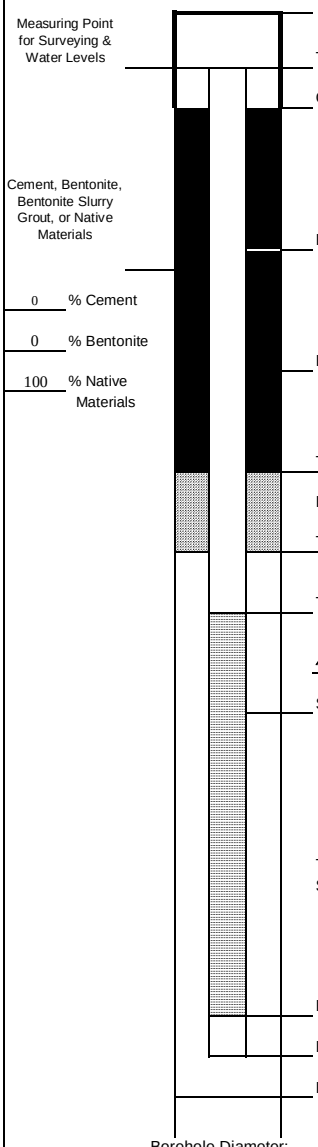
Approved: _____ (Signature) _____ (Date)

Describe Measuring Point:

Top of PVC.

AECOM	Client: Town of Orleans	**WELL ID: LH-4**
	Project Number: 60476644	
	Site Location: Orleans, MA	Date Installed: 01/04/2018
	Well Location: 32 Lots Hollow Coords:	Inspector: Erika Amir-Lin
	Method: CME truck mounted hollow-stem auger	Contractor: Desmond Drilling

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet)
Top of Steel Guard Pipe	+3	
Top of Riser Pipe		
Ground Surface (G.S.)	0.0	
Riser Pipe:		
Length: 114		
Inside Diameter (ID): 2-inch		
Type of Material: PVC		
Bottom of Steel Guard Pipe		
Top of Bentonite	114	
Bentonite Seal Thickness: 2 feet		
Top of Sand	N/A	
Top of Screen	114.0	
▲ Stabilized Water Level	103	
Screen:		
Length: 10		
Inside Diameter (ID): 2 inch		
Slot Size: 0.01		
Type of Material: PVC		
Type/Size of Sand: native material		
Sand Pack Thickness: N/A		
Bottom of Screen	124	
Bottom of Tail Pipe:	N/A	
Bottom of Borehole	124	

Borehole Diameter: 6-inch

Approved: _____ (Signature) _____ (Date)

Describe Measuring Point:

Top of PVC.

Project Number: 60476644
Client:
City of Orleans
Orleans, MA
Site Location:
32 Lots Hollow Road; Water Tower
Orleans, MA

AECOM
250 Apollo Drive
Chelmsford, Massachusetts
(978) 905-2100

Boring Log LH-5

Boring Number: **5**
Sheet: 1 of 4
Surface Elevation (ft-asl):
Equipment: CME
Inside Diameter:

Project Manager: M. Owen
Drilling Contractor: Desmond
Field Tech: E. Amir-Lin
Driller: Tommy/Josh
Date Started: 12/15/2017
Date Completed: 12/19/2017

Well Data

Boring Depth: 134 feet
Screen Depth: 115-125 feet
Screen length: 10 feet
Water Level: ~104 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
1									Well completed with 3 foot metal standpipe and concrete pad				1
2						25	dry	2" Brown loam. 24" Yellow-brown M SAND, little F sand, trace C sand, trace F rounded gravel.					2
3													3
4													4
5													5
6						21	dry	21" Light brown M SAND, intermittent Fe stained bands.					6
7													7
8													8
9													9
10						40	dry	18" Light brown M SAND, little C sand, Fe staining. 6" Light brown F SAND. 16" Light brown M SAND, little C sand, Fe staining.					10
11													11
12													12
13													13
14						22	dry	22" Light brown to orange-brown M SAND, some C sand, little F sand, trace F rounded gravel.					14
15									Schedule 40 PVC riser to surface Natural formation pack				15
16													16
17		No Blow Counts Collected - Drilled Direct Push to 80 feet											17
18						23	dry	23" Light brown M SAND, little F sand, trace C sand, trace F rounded gravel, mottled Fe stain.					18
19													19
20													20
21													21
22						28	dry	28" Light brown M SAND, some C sand, little F sand, trace F subrounded gravel, Fe staining.					22
23													23
24													24
25													25
26						34	dry	26" Tan M SAND, little C sand, trace F sand, trace F rounded gravel, occasional Fe stain. 8" Reddish brown C SAND, little F gravel, one piece C angular gravel, little M sand, trace F sand.					26
27													27
28													28
29													29
30						30	moist	30" Light brown M SAND, some C sand, little F sand, little F-C gravel.					30
31													31
32													32
33													33

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644 *Client:* City of Orleans Orleans, MA *Site Location:* 32 Lots Hollow Road; Water Tower Orleans, MA	AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100	***Boring Log LH-5*** *Boring Number:* **5** *Sheet:* 1 of 4 *Surface Elevation (ft-asl):* *Equipment:* CME *Inside Diameter:*
Project Manager: M. Owen *Drilling Contractor:* Desmond	*Field Tech:* E. Amir-Lin *Driller:* Tommy/Josh	*Date Started:* 12/15/2017 *Date Completed:* 12/19/2017

Well Data

Boring Depth: 134 feet
Screen Depth: 115-125 feet
Screen length: 10 feet
Water Level: ~104 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
34		No Blow Counts Collected - Drilled Direct Push to 80 feet				30	moist	8" Light brown M SAND, some C sand, little F sand, little F-C gravel. 22" Brown/tan mottled M SAND, little fine sand.	Schedule 40 PVC riser to surface Natural formation pack				34
35													35
36						29"	moist	29" Brown-tan M SAND, little F sand, trace C sand.					36
37													37
38													38
39													39
40						42	moist	42" Light brown-tan M SAND, little F sand, little C sand, lens of brown M and C sand at 43.3 feet.					40
41													41
42													42
43													43
44						40	moist	40" Light brown-tan M SAND, little F, trace C, Fe staining.					44
45													45
46													46
47													47
48						32	moist	Same as above, decreasing Fe staining.					48
49													49
50													50
51													51
52						26	moist	26" Tan M SAND, little F sand, little C sand, trace F subangular gravel.					52
53													53
54													54
55													55
56						30	moist	10" Tan M SAND, occasional Fe staining. 3" Grey/brown mottled SILT. 5" Tan F SAND, Fe stain. 12" Tan M SAND, some F sand, occasional Fe staining.					56
57													57
58													58
59													59
60						31	moist	31" Tan M SAND, little F sand, occasional dark brown bands.					60
61													61
62													62
63													63
64						36	moist	36" Tan-light brown M SAND, little F sand, occasional Fe stain.					64
65													65
66													66

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644 *Client:* City of Orleans Orleans, MA *Site Location:* 32 Lots Hollow Road; Water Tower Orleans, MA	AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100	***Boring Log LH-5*** *Boring Number:* **5** *Sheet:* 1 of 4 *Surface Elevation (ft-asl):* *Equipment:* CME *Inside Diameter:*
Project Manager: M. Owen *Drilling Contractor:* Desmond	*Field Tech:* E. Amir-Lin *Driller:* Tommy/Josh	*Date Started:* 12/15/2017 *Date Completed:* 12/19/2017

Well Data

Boring Depth: 134 feet
Screen Depth: 115-125 feet
Screen length: 10 feet
Water Level: ~104 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
67													67
68						38	moist	38" Tan-light brown M SAND, little F sand, trace Fe stain.					68
69													69
70													70
71													71
72						25	moist	21" Same as above, two C gravel pieces. 4" Brown F SAND with SILT.					72
73													73
74													74
75													75
76						24	moist	24" Tan-light brown M SAND, little F sand, Fe staining.	Schedule 40 PVC riser to surface Natural formation pack				76
77													77
78													78
79													79
80						22	moist	22" Tan M SAND, little F sand, clean.					80
81													81
82		No Blow Counts Collected - Drilled Direct Push to 80 feet, then downhole hammer employed				22	moist	22" Light brown M SAND, little F sand, clean.					82
83													83
84						21	moist	21" Same as above.					84
85													85
86						19	moist	19" Tan M SAND, little F sand, clean.					86
87													87
88						20	moist	20" Light brown to tan M SAND, little F sand.					88
89													89
90						21	moist	21" Light brown M SAND, little F sand.					90
91													91
92						24	moist	24" Same as above.					92
93													93
94						24	moist	24" Same as above.					94
95													95
96						11	moist	11" Tan M SAND, little F sand.					96
97													97
98						24	moist	24" Light brown M SAND, little F sand, faint Fe staining.					98
99													99

Notes: F=Fine, M=Medium, C=Coarse

Project Number: 60476644 *Client:* City of Orleans Orleans, MA *Site Location:* 32 Lots Hollow Road; Water Tower Orleans, MA	AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100	***Boring Log LH-5*** *Boring Number:* **5** *Sheet:* 1 of 4 *Surface Elevation (ft-asl):* *Equipment:* CME *Inside Diameter:*
Project Manager: M. Owen *Drilling Contractor:* Desmond	*Field Tech:* E. Amir-Lin *Driller:* Tommy/Josh	*Date Started:* 12/15/2017 *Date Completed:* 12/19/2017

Well Data

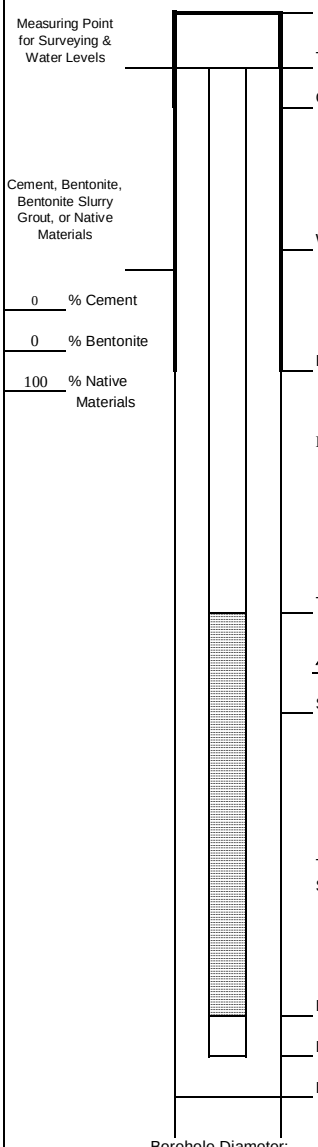
Boring Depth: 134 feet
Screen Depth: 115-125 feet
Screen length: 10 feet
Water Level: ~104 feet

Depth	Sample Depth	Blow Counts (24") 0-6	6-12	12-18	18-24	Rec (")	Moisture	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
100													100
101						19	moist	19" Tan M SAND, some F sand, faint Fe staining.					101
102													102
103						24	moist	24" Light brown M SAND, little F sand.					103
104							moist -						104
105						24	wet	24" Brown M sand, some F sand.	Time-release bentonite chip seal.				105
106													106
107						19	wet	19" Same as above.					107
108													108
109						22	wet	22" Brown M and F SAND.					109
110									Schedule 40 PVC riser to surface Natural formation pack				110
111						24	wet	24" Same as above.					111
112													112
113						18	wet	24" Same as above.					113
114													114
115						22	wet	22" Brown M SAND, some F sand.					115
116		No Blow Counts Collected - Drilled Direct Push to 80 feet, then downhole hammer employed											116
117						24	wet	19" Brown M SAND, some F sand. 5" Brown SANDY SILT.					117
118									0.010 slot PVC screen				118
119						24	wet	24" Brown M and F SAND, becoming M with some F at bottom of spoon.					119
120								5" Brown M and F SAND.					120
121						24	wet	1" Brown SILT. 18" Light brown M SAND, little F sand.					121
122													122
123						24	wet	3" Same as above. 21" Brown F and M SAND.					123
124													124
125						24	wet	24" Brown F SAND, little M sand.					125
126													126
127						21	wet	21" Same as above.					127
128													128
129						24	wet	24" Brown F SAND, trace M sand, clean.					129
130													130
131						20	wet	20" Same as above.					131
132													132
133						18	wet	18" Brown M SAND, some F sand.					133
134								**Bottom of Boring at 134 feet**					134
135													135

Notes: F=Fine, M=Medium, C=Coarse

AECOM	*Client: Town of Orleans*	***Test Wick - 32 Lots Hollow***
	Project Number: 60476644	
	Site Location: Orleans, MA	*Date Installed: 02/06/2018*
	Well Location: 32 Lots Hollow Coords:	*Inspector: Erika Amir-Lin*
	Method: CME truck mounted hollow-stem auger	*Contractor: Desmond Drilling*

WICK DISCHARGE CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet)
Top of Plastic Culvert Pipe (6-foot diameter)	+2	
Top of PVC well	+1	
Ground Surface (G.S.)	0.0	
Well Riser Pipe: Length 25; Inside Diameter (ID) 2-inch; Type of Material PVC		
Bottom of Plastic Culvert Pipe	4	
Note: PVC well set in center of the wick.	N/A	
	N/A	
Top of Screen	25	
▲ Stabilized Water Level	above water table	
Screen: Length 80; Inside Diameter (ID) 2 inch; Slot Size 0.01; Type of Material PVC		
Type/Size of Sand 3/8" gravel - ; Sand Pack Thickness 5 inches		
Bottom of Screen	105	
Bottom of Tail Pipe:	N/A	
Bottom of Borehole	105	

Borehole Diameter: 12-inch

Approved: _____ Signature _____ Date

Describe Measuring Point:

Top of PVC.

Appendix C

Laboratory Reports - Soils

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SOILS LABORATORY TESTING ASSIGNMENT SHEET

THIELSCH ENGINEERING 401-467-6454 195 Frances Ave., Cranston, RI 02910

Project Name **Orleans - GWDP** Client **Town of Orleans** Assigned By

CTS Project No. **60476644.01.01** Site Location LH = Lots Hollow MW = 43 Lots Hollow Collected By **Mark Owen**

ESS Project No. Date Assigned Received By

Project Manager **T. Parece** Date Received Date Required Normal

Sample Information					Lab No.	Identification Tests							Permeability		Compaction			Strength		Consol.	Notes
Boring/ Test Pit No.	Sample No.	Depth Ft.	Sample Date	ESS SAMPLE ID		Water Cont. %	LL & PL %	Org. %	Sieve -200 %	Hyd -2μ %	G_s	γ_t pcf	Sand	Clay	Mod.	Std.	CBR	Tor-vane	Type Test $\frac{}{\sigma_c}$ or σ^c	Cc/ 1+eo	#
						D2216	D4318	D2974	D422		D854		D2434	D5084	D1557	D698	D1883		D2166/ D4767/ D2850	D2435	#
LH-2	1	36-40	12/14/17						X												
LH-5	1	80-96	12/18/17						X												
LH-2	2	106	12/20/17						X	X											
LH-5	2	118	12/19/17						X	X											
LH-5	3	124-132	12/19/17						X												
LH-2	3	106-108	12/20/17						X												
MW-2 (235-245)	1	36	7/20/17						X												
MW-2 (235-245)	2	66	7/20/17						X												
MW-2 (235-245)	3	101	7/20/17						X	X											
MW-2 (235-245)	4	165	7/20/17						X	X											
MW-2 (235-245)	5	186-196	7/21/17						X												
MW-2 (235-245)	6	226	7/21/17						X												

Notes: Samples with LH Designation = 32 Lots Hollow, Samples with MW designation = 43 Lots Hollow

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
http://www.thielsch.com
Let's Build a Solid Foundation

Client Information:
AECOM / Town Of Orleans
Boston, MA
PM: Tom Parece
Collected By: Mark Owen
Client Project #: 60476644.01.01

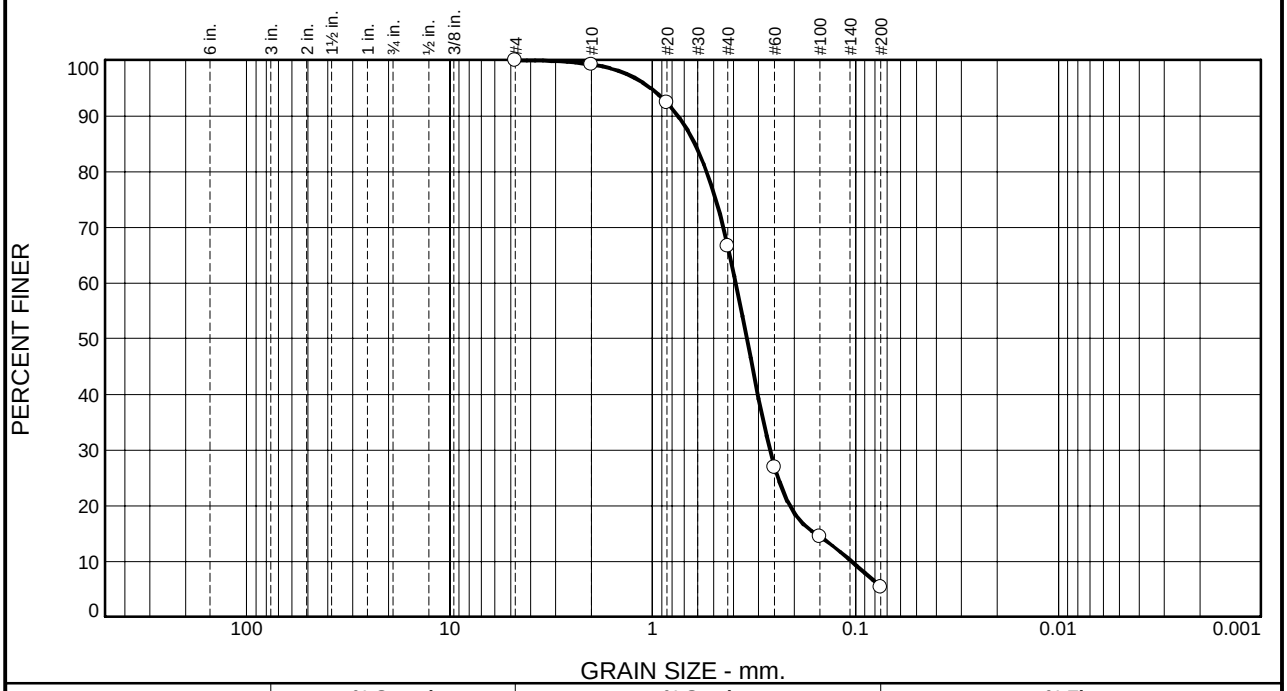
Project Information:
Orleans - GWDP
Orleans, MA
TEI Project Number: 60476644.01.01
Summary Page: 1 of 1
Report Date: 02.23.18

LABORATORY TESTING DATA SHEET

Boring ID / Source	Sample No. / Material	Depth (ft)	CTS Laboratory No.	Identification Tests						Corrosivity Tests								Laboratory Log and Soil Description
				Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Sulfide (mg/kg)	Redox Potential (mv)	Electrical Resist. As Received Ohm-cm	Electrial Resist. Saturated Ohm-cm	Other	
LH-2	1	30-40	18-S-163				0.0	94.6	5.4									Brown poorly graded sand with silt (SP - SM)
LH-5	1	80-96	18-S-164				0.0	97.2	2.8									Brown poorly graded sand (SP)
LH-2	2	106	18-S-165				0.0	20.4	79.6									Grey-brown silt with sand (ML)
LH-5	2	118	18-S-166				0.0	22.0	78.0									Brown silt with sand (ML)
LH-5	3	124-132	18-S-167				0.0	96.7	3.3									Brown poorly graded sand (SP)
LH-2	3	106-108	18-S-168				0.0	76.6	23.4									Brown silty sand (SM)
MW-2 (235-245)	1	36	18-S-169				0.0	78.6	21.4									Brown silty sand (SM)
MW-2 (235-245)	2	66	18-S-170				0.0	97.0	3.0									Brown poorly graded sand (SP)
MW-2 (235-245)	3	101	18-S-171				0.0	7.2	92.8									Brown silt (ML)
MW-2 (235-245)	4	165	18-S-172				0.0	58.3	41.7									Grey sandy silt (SM)
MW-2 (235-245)	5	186-196	18-S-173				0.0	94.4	5.6									Gray poorly graded sand with silt (SP - SM)
MW-2 (235-245)	6	226	18-S-174				0.0	95.0	5.0									Gray poorly graded sand with silt (SP - SM)

Reviewed By _____ Date Reviewed *02.26.18*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	32.6	61.2	5.4	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.2		
#20	92.4		
#40	66.6		
#60	26.9		
#100	14.5		
#200	5.4		

* (no specification provided)

Material Description

Brown poorly graded sand with silt (SP - SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.7483 D_{85}= 0.6191 D_{60}= 0.3887
D_{50}= 0.3433 D_{30}= 0.2636 D_{15}= 0.1577
D_{10}= 0.1044 C_u= 3.72 C_c= 1.71

Remarks

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 30-40' **Date Sampled:** 12.14.17

Sample Number: LH-2 / S-1

Thielsch Engineering Inc.

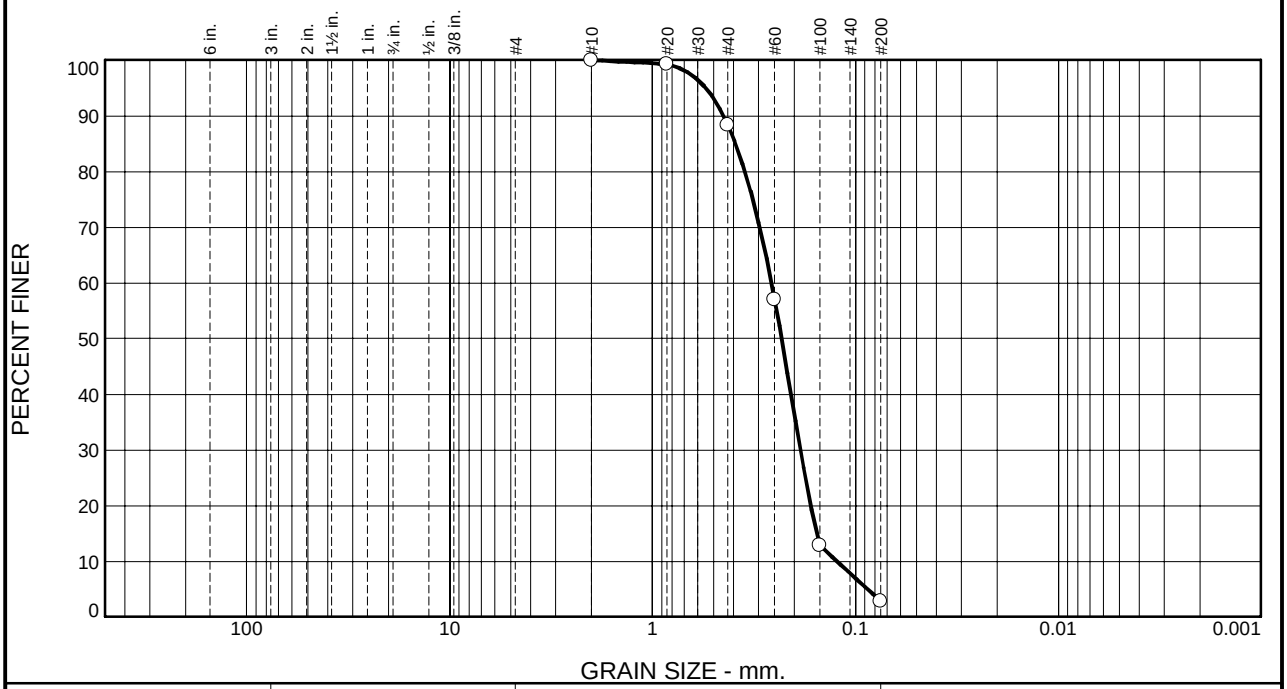
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-163

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	11.7	85.5	2.8	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.3		
#40	88.3		
#60	57.0		
#100	12.9		
#200	2.8		

* (no specification provided)

Material Description

Brown poorly graded sand (SP)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.4468 D_{85}= 0.3902 D_{60}= 0.2592
D_{50}= 0.2310 D_{30}= 0.1866 D_{15}= 0.1550
D_{10}= 0.1231 C_u= 2.11 C_c= 1.09

Remarks

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 80-96' **Date Sampled:** 12.18.17

Sample Number: LH-5 / S-1

Thielsch Engineering Inc.

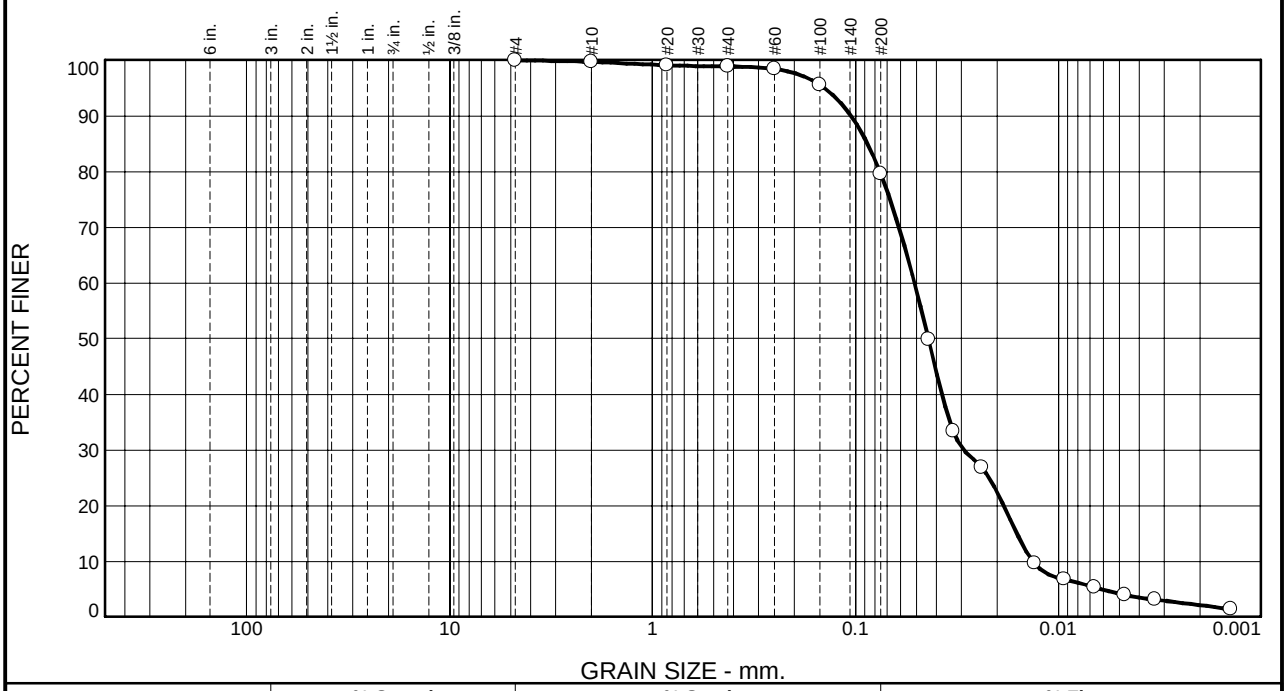
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-164

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.3	0.8	19.3	77.5	2.1

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.7		
#20	99.1		
#40	98.9		
#60	98.4		
#100	95.6		
#200	79.6		
0.0436 mm.	49.9		
0.0330 mm.	33.4		
0.0239 mm.	26.9		
0.0131 mm.	9.6		
0.0093 mm.	6.8		
0.0066 mm.	5.3		
0.0047 mm.	4.0		
0.0033 mm.	3.1		
0.0014 mm.	1.4		

* (no specification provided)

Material Description

Grey-brown silt with sand (ML)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.1051 D_{85}= 0.0872 D_{60}= 0.0511
D_{50}= 0.0437 D_{30}= 0.0292 D_{15}= 0.0160
D_{10}= 0.0133 C_u= 3.84 C_c= 1.25

Remarks

Material was visually checked for plasticity and rolled to approximatley 3/16" thread diameter.

Date Received: 02.20.18 **Date Tested:** 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 106' **Date Sampled:** 12.20.17

Sample Number: LH-2 / S-2

Thielsch Engineering Inc.

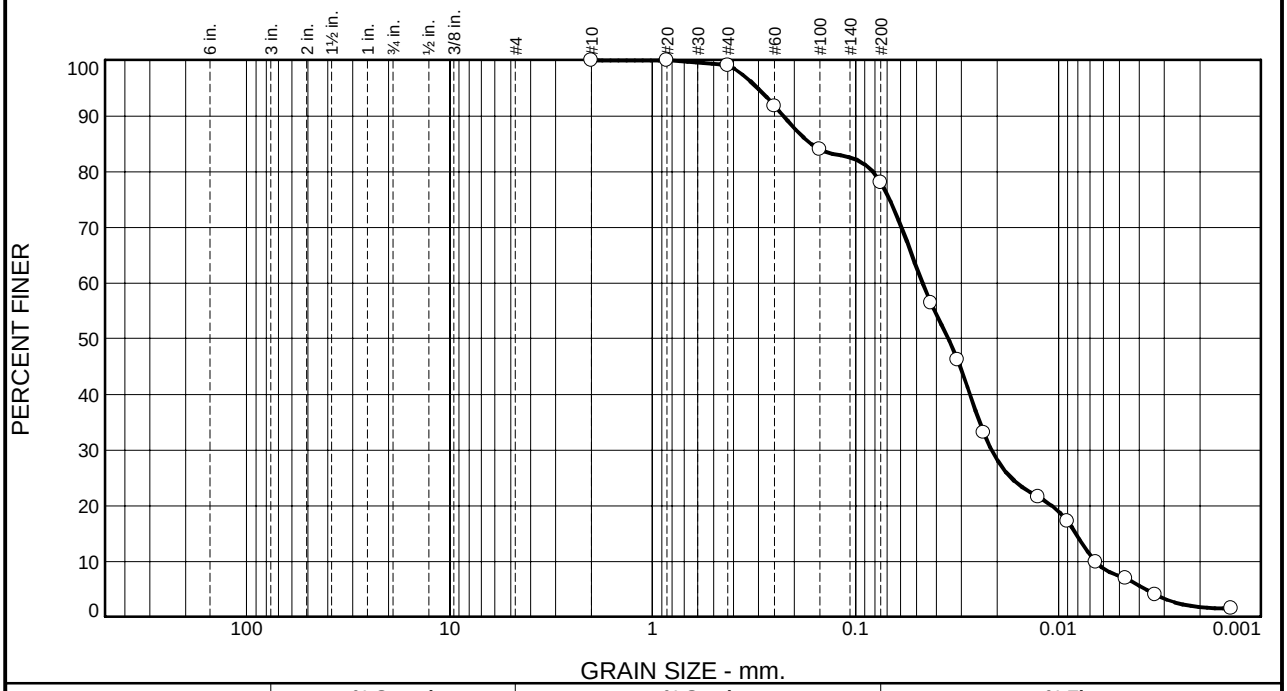
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-165

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.9	21.1	76.2	1.8

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	99.1		
#60	91.8		
#100	84.0		
#200	78.0		
0.0425 mm.	56.4		
0.0314 mm.	46.2		
0.0234 mm.	33.1		
0.0126 mm.	21.5		
0.0090 mm.	17.2		
0.0065 mm.	9.9		
0.0047 mm.	6.9		
0.0033 mm.	4.0		
0.0014 mm.	1.5		

* (no specification provided)

Material Description

Brown silt with sand (ML)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.2269 D_{85}= 0.1658 D_{60}= 0.0467
D_{50}= 0.0348 D_{30}= 0.0213 D_{15}= 0.0082
D_{10}= 0.0066 C_u= 7.10 C_c= 1.48

Remarks

Material was visually checked for plasticity and rolled to 3/16 thread diameter.

Date Received: 02.20.18 **Date Tested:** 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 118' **Date Sampled:** 12.19.17

Sample Number: LH-5 / S-2

Thielsch Engineering Inc.

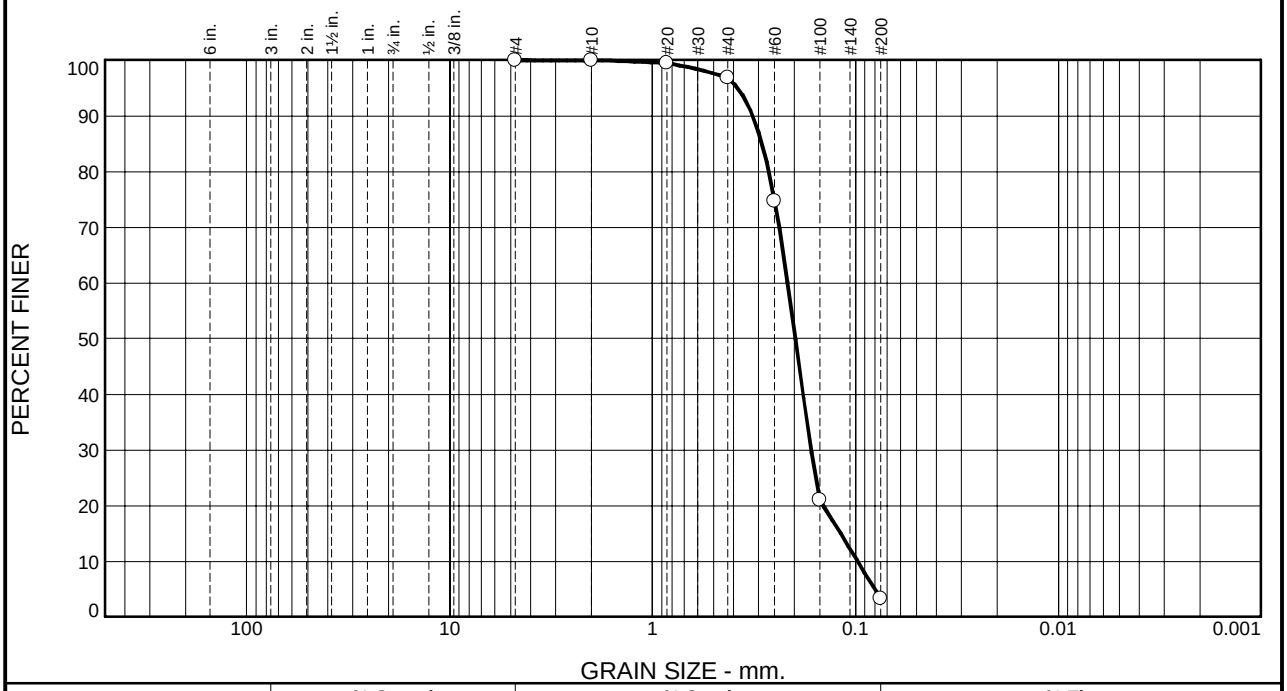
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-166

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.2	93.5	3.3	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	99.5		
#40	96.8		
#60	74.7		
#100	21.0		
#200	3.3		

* (no specification provided)

Material Description

Brown poorly graded sand (SP)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.3207 D_{85}= 0.2889 D_{60}= 0.2159
D_{50}= 0.1977 D_{30}= 0.1652 D_{15}= 0.1185
D_{10}= 0.0974 C_u= 2.22 C_c= 1.30

Remarks

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 124-132' **Date Sampled:** 12.19.18

Sample Number: LH-5 / S-3

Thielsch Engineering Inc.

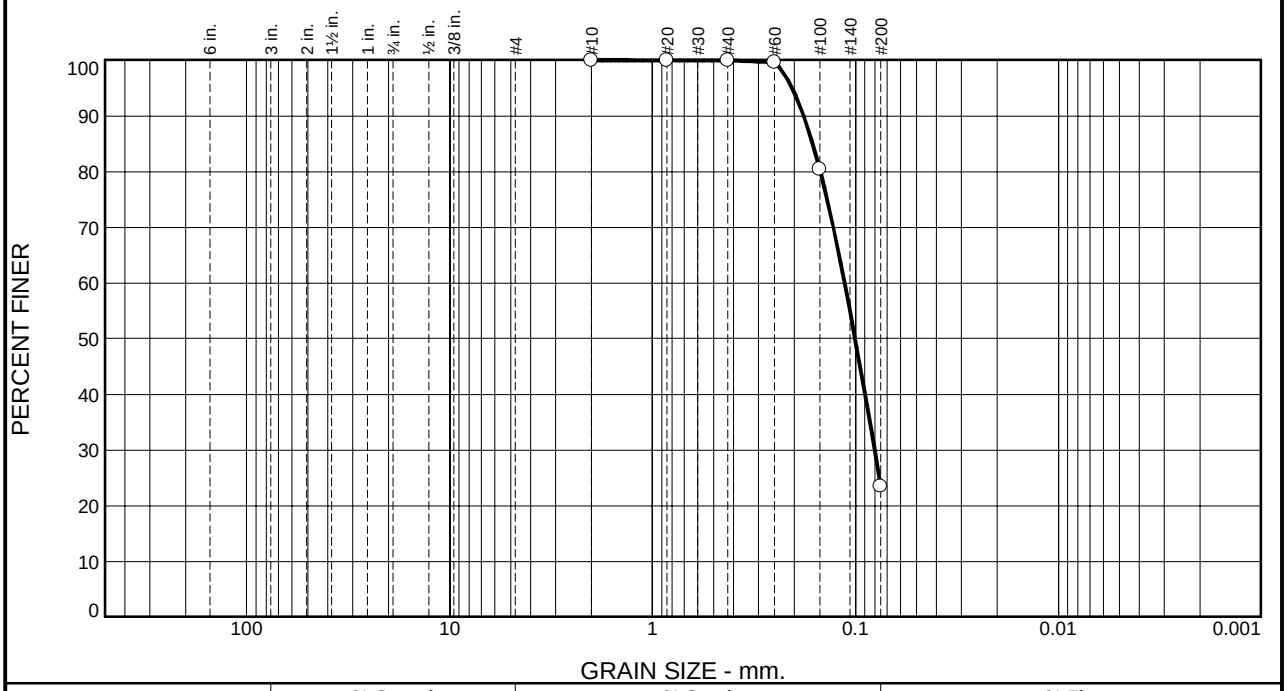
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-167

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	76.6	23.4	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.6		
#100	80.4		
#200	23.4		

* (no specification provided)

Material Description

Brown silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1801 D_{85}= 0.1625 D_{60}= 0.1130
D_{50}= 0.1004 D_{30}= 0.0805 D_{15}=
D_{10}= C_u= C_c=

Remarks

Material was visually checked for plasticity and appeared non-plastic.

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 106-108' **Date Sampled:** 12.20.17

Sample Number: LH-2 / S-3

Thielsch Engineering Inc.

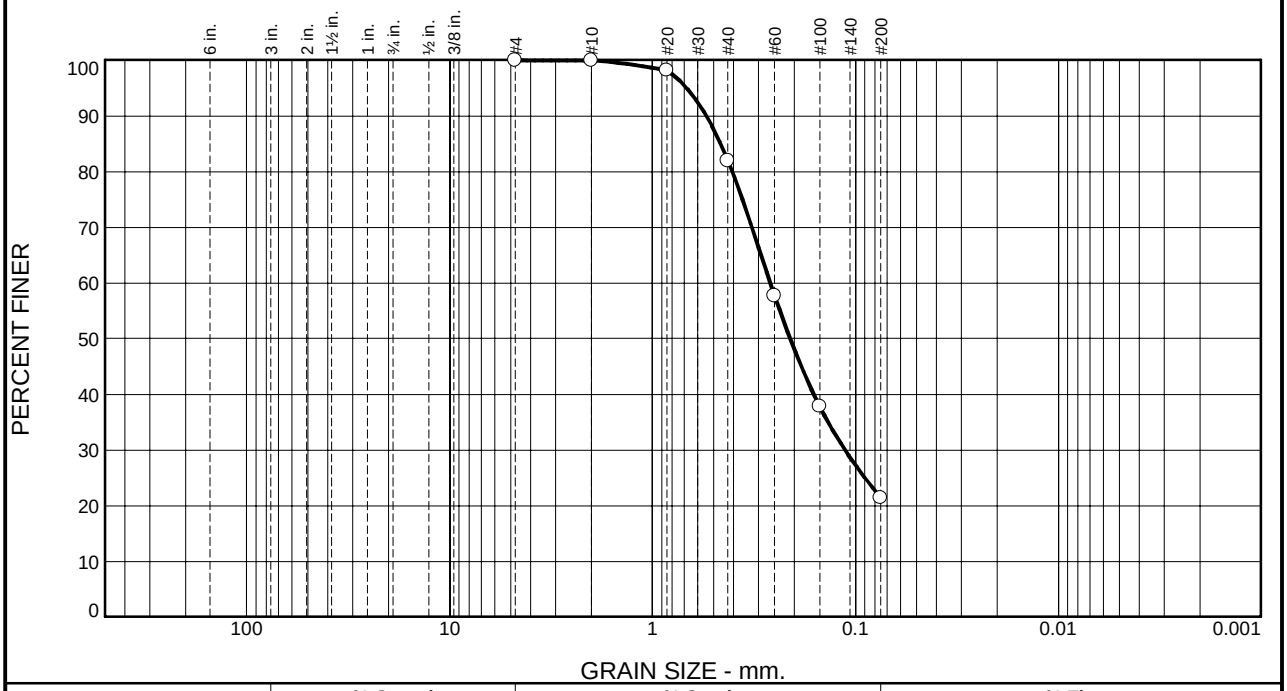
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-168

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	18.1	60.5	21.4	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	100.0		
#20	98.2		
#40	81.9		
#60	57.7		
#100	37.8		
#200	21.4		

* (no specification provided)

Material Description

Brown silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.5430 D_{85}= 0.4618 D_{60}= 0.2628
D_{50}= 0.2097 D_{30}= 0.1126 D_{15}=
D_{10}= C_u= C_c=

Remarks

Material was visually checked for plasticity and appeared non-plastic.

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 36' **Date Sampled:** 07.20.17

Sample Number: MW-2 / S-1

Thielsch Engineering Inc.

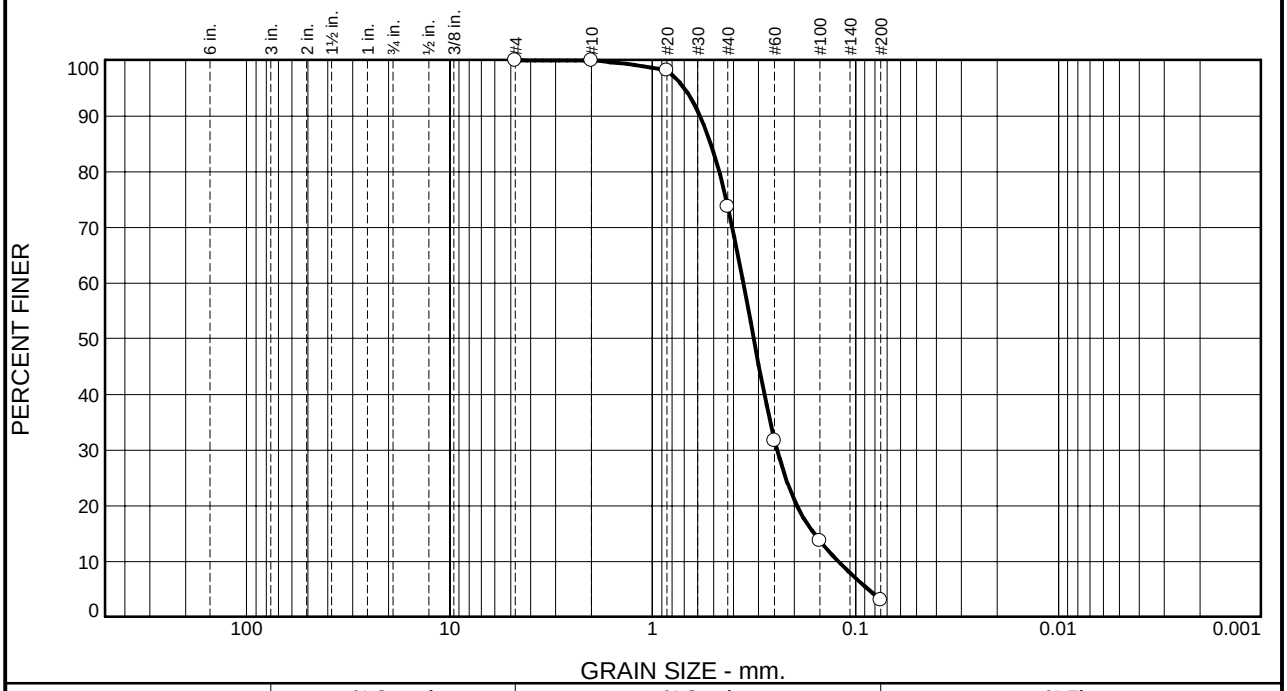
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-169

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	26.2	70.7	3.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.2		
#40	73.7		
#60	31.7		
#100	13.7		
#200	3.0		

* (no specification provided)

Material Description

Brown poorly graded sand (SP)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP **AASHTO (M 145)=**

Coefficients

D_{90}= 0.5840 D_{85}= 0.5166 D_{60}= 0.3570
D_{50}= 0.3175 D_{30}= 0.2433 D_{15}= 0.1602
D_{10}= 0.1215 C_u= 2.94 C_c= 1.36

Remarks

Date Received: 02.20.17 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman, P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 66' **Date Sampled:** 07.20.17

Sample Number: MW-2 / S-2

Thielsch Engineering Inc.

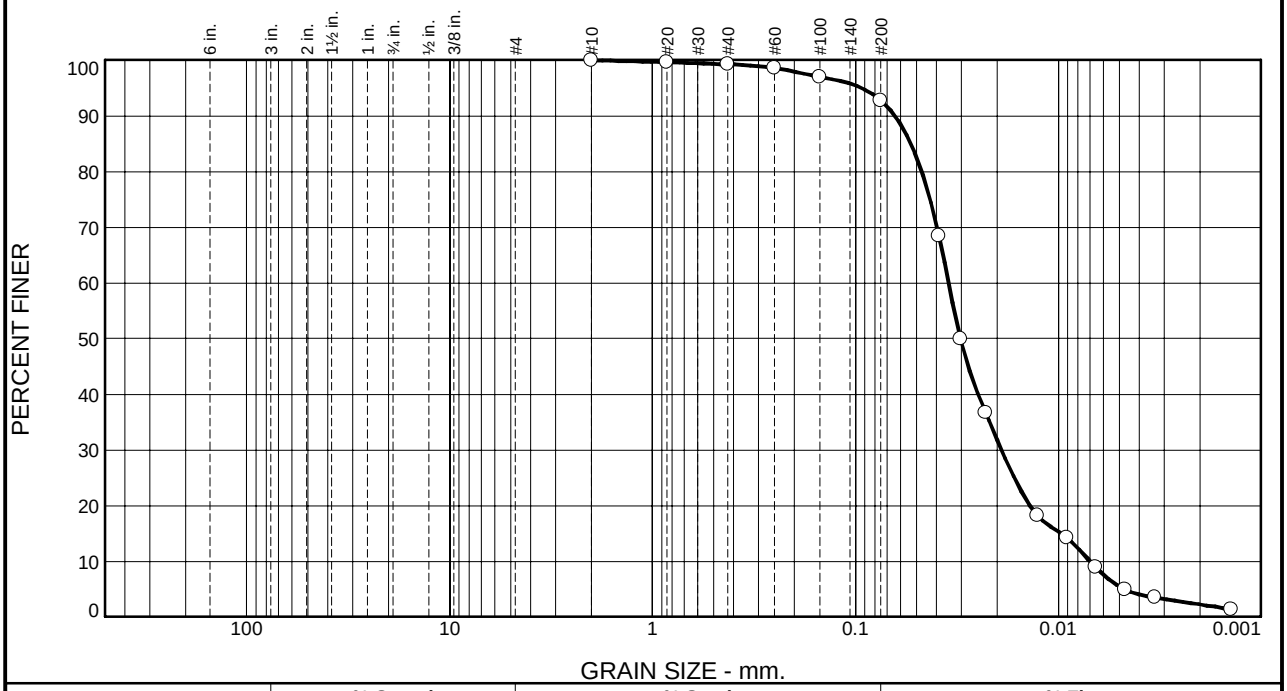
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-170

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.7	6.5	90.5	2.3

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.7		
#40	99.3		
#60	98.6		
#100	97.0		
#200	92.8		
0.0388 mm.	68.4		
0.0303 mm.	49.9		
0.0228 mm.	36.7		
0.0126 mm.	18.2		
0.0091 mm.	14.2		
0.0065 mm.	8.9		
0.0047 mm.	4.9		
0.0033 mm.	3.5		
0.0014 mm.	1.4		

* (no specification provided)

Material Description

Brown silt (ML)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= ML **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.0638 D_{85}= 0.0533 D_{60}= 0.0347
D_{50}= 0.0303 D_{30}= 0.0190 D_{15}= 0.0097
D_{10}= 0.0070 C_u= 4.98 C_c= 1.50

Remarks

Material was visually checked for plasticity and appeared non-plastic.

Date Received: 02.20.18 **Date Tested:** 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 101' **Date Sampled:** 07.20.17

Sample Number: MW-2 / S-3

Thielsch Engineering Inc.

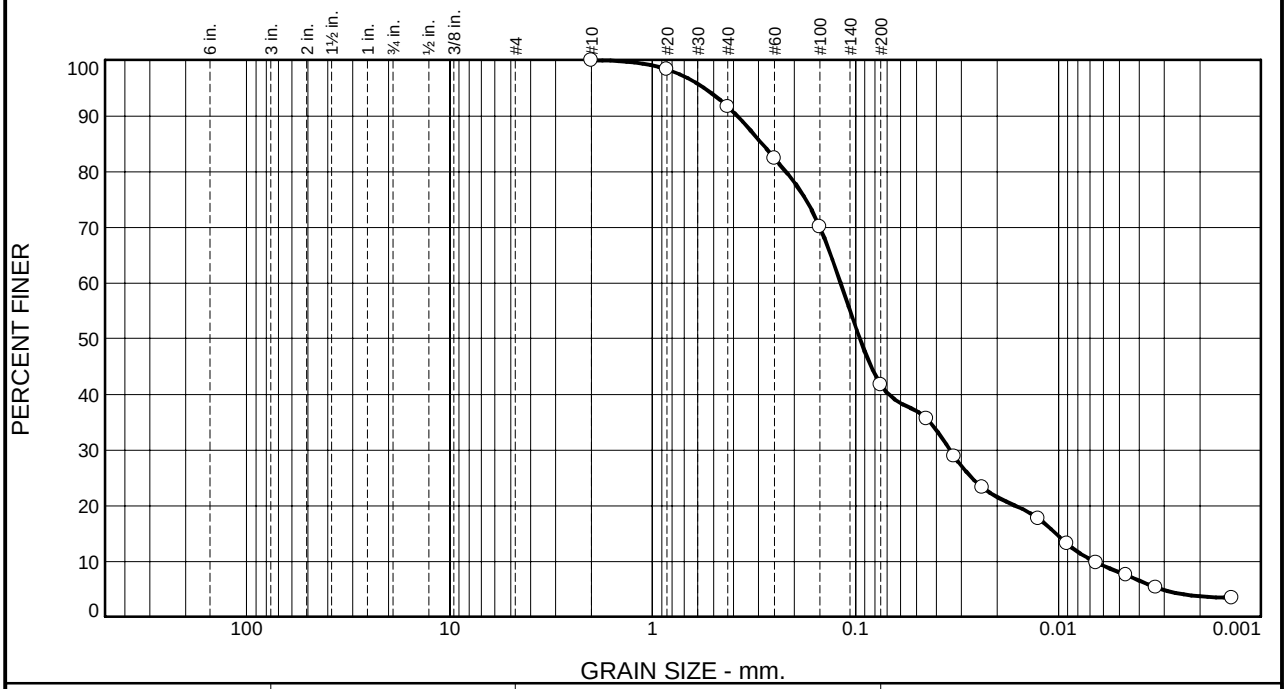
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-171

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	8.4	49.9	38.0	3.7

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	98.3		
#40	91.6		
#60	82.4		
#100	70.1		
#200	41.7		
0.0445 mm.	35.6		
0.0326 mm.	28.9		
0.0237 mm.	23.3		
0.0125 mm.	17.7		
0.0090 mm.	13.2		
0.0065 mm.	9.8		
0.0046 mm.	7.6		
0.0033 mm.	5.3		
0.0014 mm.	3.4		

* (no specification provided)

Material Description

Grey silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.3830 D_{85}= 0.2886 D_{60}= 0.1185
D_{50}= 0.0952 D_{30}= 0.0342 D_{15}= 0.0103
D_{10}= 0.0067 C_u= 17.72 C_c= 1.48

Remarks

Material was visually checked for plasticity and appeared non-plasitc.

Date Received: 02.20.18 **Date Tested:** 02.23.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 165' **Date Sampled:** 07.20.17

Sample Number: MW-2 / S-4

Thielsch Engineering Inc.

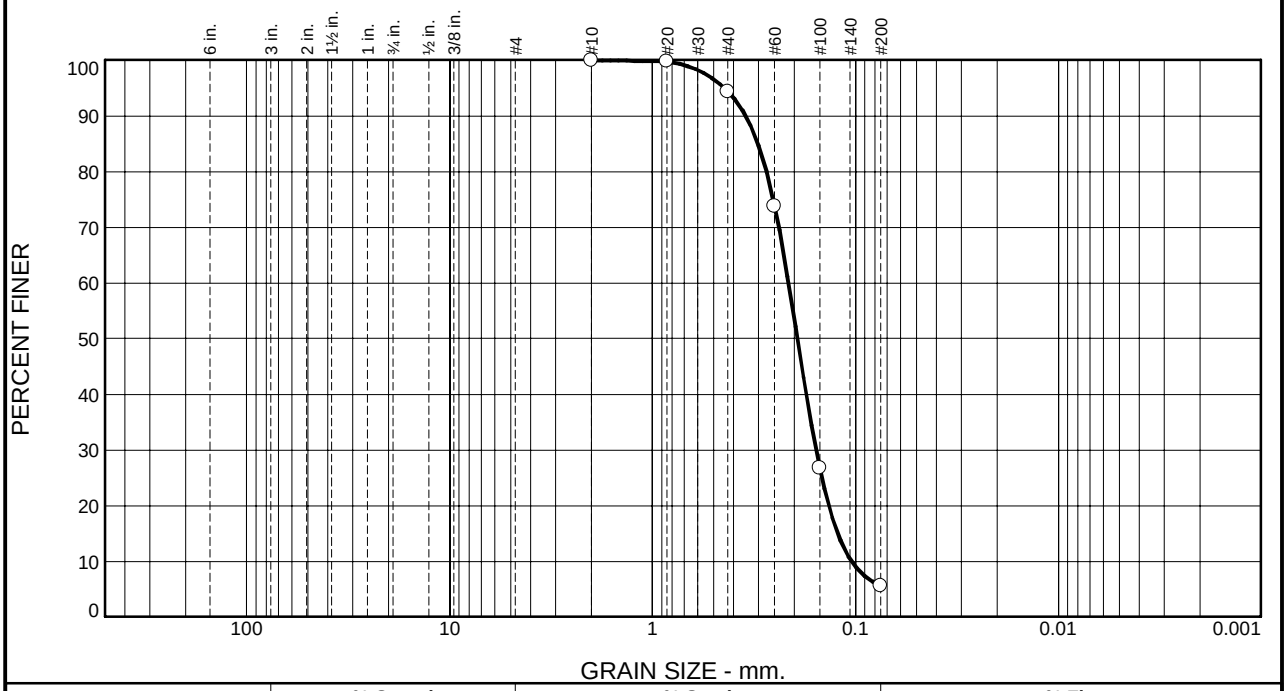
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-172

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	5.7	88.7	5.6	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	94.3		
#60	73.8		
#100	26.8		
#200	5.6		

* (no specification provided)

Material Description

Gray poorly graded sand with silt (SP - SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.3469 D_{85}= 0.3022 D_{60}= 0.2137
D_{50}= 0.1932 D_{30}= 0.1563 D_{15}= 0.1222
D_{10}= 0.1045 C_u= 2.04 C_c= 1.09

Remarks

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 186-196' **Date Sampled:** 07.21.18

Sample Number: MW-2 / S-5

Thielsch Engineering Inc.

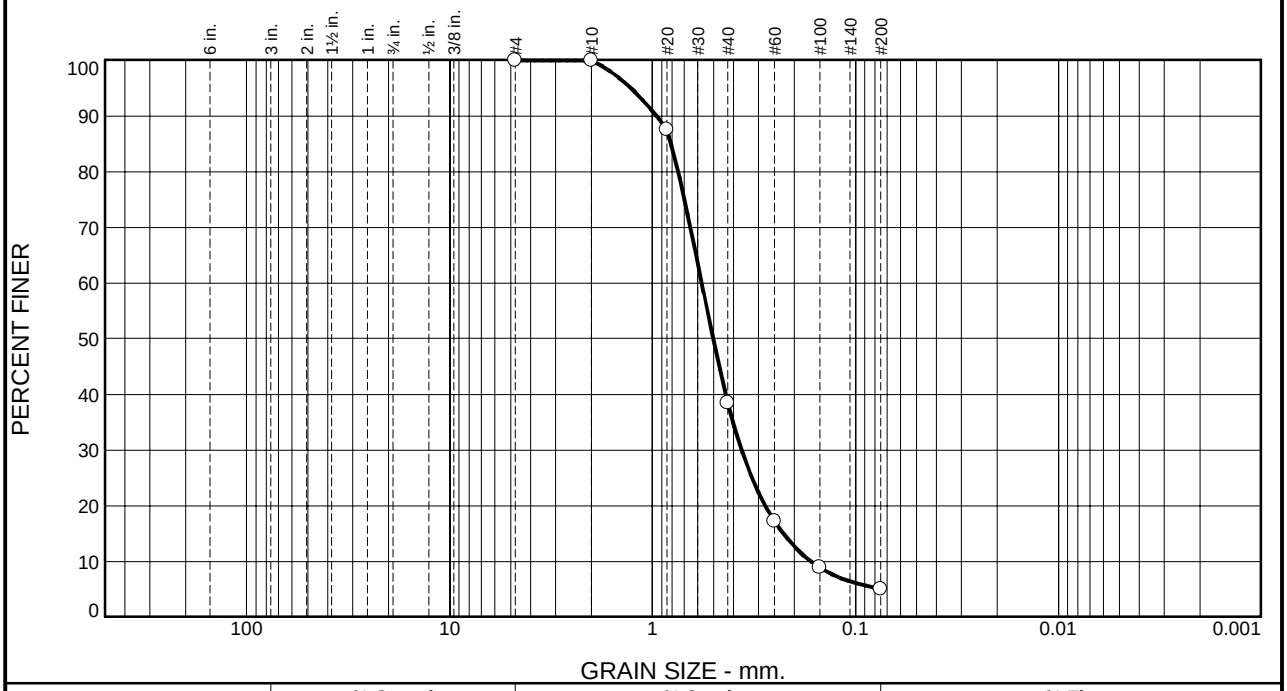
Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-173

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	61.5	33.4	5.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	87.5		
#40	38.4		
#60	17.2		
#100	8.9		
#200	5.0		

* (no specification provided)

Material Description

Gray poorly graded sand with silt (SP - SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 0.9576 D_{85}= 0.8116 D_{60}= 0.5720
D_{50}= 0.5023 D_{30}= 0.3639 D_{15}= 0.2267
D_{10}= 0.1660 C_u= 3.45 C_c= 1.39

Remarks

Date Received: 02.20.18 **Date Tested:** 02.22.18

Tested By: MN

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Exploratory Samples **Depth:** 226' **Date Sampled:** 07.21.17

Sample Number: MW-2 / S-6

Thielsch Engineering Inc.

Cranston, RI

Client: AECOM / Town Of Orleans

Project: Orleans-GWDP
Orleans, MA

Project No: 06476644.01.01 **Figure** 18-S-174

Appendix D

Pumping Test Water Level Data

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DESMOND WELL DRILLING Inc.
CAPE COD TEST BORING

Client: AECOM/Town of Orleans
Job location: Orleans Landfill - Well PW1 (130-160)

24 hour pump test results and notes

Date/Time	GPM	Water level (ft) top of poly sleeve		Date/Time	GPM	Water level (ft)
8/3/17 10:00 AM	83	89.95				
8/3/17 10:01 AM	83	96.50				
8/3/17 10:02 AM	83	101.39				
8/3/17 10:03 AM	83	101.52				
8/3/17 10:04 AM	83	101.61				
8/3/17 10:05 AM	83	101.66				
8/3/17 10:06 AM	83	101.68				
8/3/17 10:07 AM	83	101.70				
8/3/17 10:08 AM	83	101.75				
8/3/17 10:09 AM	83	101.75				
8/3/17 10:10 AM	83	101.75				
8/3/17 10:11 AM	83	101.75				
8/3/17 10:12 AM	83	101.75				
8/3/17 10:20 AM	83	101.78				
8/3/17 10:30 AM	83	101.78				
8/3/17 10:40 AM	83	101.78				
8/3/17 10:50 AM	83	101.78				
8/3/17 11:00 AM	83	101.78				
8/3/17 11:10 AM	83	101.78				
8/3/17 11:20 AM	83	101.78				
8/3/17 12:20 PM	83	101.78				
8/3/17 2:20 PM	83	101.76				
8/3/17 4:20 PM	83					

Well depth:	160'	Top of pipe
Static:	87.9'	Top of pipe
Well screen:	4"x30'x.012 st/st	
Pump length:	42.8"	
Motor length:	27.7"	

5 Rayber Road
P.O. Box 2783
Orleans, MA 02653

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DESMOND WELL DRILLING Inc.
CAPE COD TEST BORING

Client: AECOM/Town of Orleans
Job location: Orleans Landfill - Well PW1 (95 to 125)

24 hour pump test results and notes

Date/Time	GPM	Water level (ft) top of poly sleeve		Date/Time	GPM	Water level (ft)
7/31/17 1:10 PM	85	89.95		7/31/17 11:40 PM	85	95.90
7/31/17 1:11 PM	85	95.44		8/1/17 3:40 AM	85	95.90
7/31/17 1:12 PM	85	95.50		8/1/17 7:40 AM	85	95.93
7/31/17 1:13 PM	85	95.50		8/1/17 9:45 AM	85	95.95
7/31/17 1:14 PM	85	95.50				
7/31/17 1:15 PM	85	95.50				
7/31/17 1:16 PM	85	95.50		**Recovery**		
7/31/17 1:17 PM	85	95.50		8/1/17 1:10 PM		95.95
7/31/17 1:18 PM	85	95.50		8/1/17 1:11 PM		91.00
7/31/17 1:19 PM	85	95.50		8/1/17 1:12 PM		90.98
7/31/17 1:20 PM	85	95.54		8/1/17 1:13 PM		90.95
7/31/17 1:30 PM	85	95.60		8/1/17 1:14 PM		90.93
7/31/17 1:40 PM	85	95.64		8/1/17 1:15 PM		90.92
7/31/17 1:50 PM	85	95.65		8/1/17 1:16 PM		90.91
7/31/17 2:00 PM	85	95.70		8/1/17 1:17 PM		90.90
7/31/17 2:10 PM	85	95.70		8/1/17 1:18 PM		90.89
7/31/17 2:20 PM	85	95.73		8/1/17 1:19 PM		90.88
7/31/17 2:30 PM	85	95.75		8/1/17 1:20 PM		90.88
7/31/17 2:40 PM	85	95.77		8/1/17 1:21 PM		90.87
7/31/17 2:50 PM	85	95.78		8/1/17 1:22 PM		90.82
7/31/17 5:50 PM	85	95.85		8/1/17 2:00 PM		90.78
7/31/17 8:35 PM	85	95.90		8/1/17 2:15 PM		90.70

Well depth:	126.55'	Top of pipe
Static:	86.4'	Top of pipe
Well screen:	4"x30'x.012 st/st	
Pump length:	42.8"	
Motor length:	27.7"	

5 Rayber Road
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DESMOND WELL DRILLING Inc.
CAPE COD TEST BORING

Client: AECOM/Town of Orleans
Job location: Orleans Landfill - Well PW2 (131-155)

8 hour pump test results and notes

Date/Time	GPM	Water level (ft)		Date/Time	GPM	Water level (ft)
8/24/17 8:00 AM	85	95.18		8/24/17 2:40 PM	85	95.40
8/24/17 8:01 AM	85	95.29		8/24/17 3:40 PM	85	95.40
8/24/17 8:02 AM	85	95.31				
8/24/17 8:03 AM	85	95.31				
8/24/17 8:04 AM	85	95.31				
8/24/17 8:05 AM	85	95.35		**Recovery**		
8/24/17 8:06 AM	85	95.35		8/24/17 4:00 PM		95.15
8/24/17 8:07 AM	85	95.35		8/24/17 4:01 PM		95.06
8/24/17 8:08 AM	85	95.35		8/24/17 4:02 PM		95.08
8/24/17 8:09 AM	85	95.35		8/24/17 4:03 PM		94.98
8/24/17 8:10 AM	85	95.35		8/24/17 4:04 PM		94.97
8/24/17 8:20 AM	85	95.36		8/24/17 4:05 PM		94.95
8/24/17 8:30 AM	85	95.37		8/24/17 4:06 PM		94.95
8/24/17 8:40 AM	85	95.38		8/24/17 4:07 PM		94.93
8/24/17 8:50 AM	85	95.38		8/24/17 4:08 PM		94.92
8/24/17 9:00 AM	85	95.38		8/24/17 4:09 PM		94.92
8/24/17 9:10 AM	85	95.37		8/24/17 4:10 PM		94.91
8/24/17 9:20 AM	85	95.39		8/24/17 4:11 PM		94.91
8/24/17 9:30 AM	85	95.39		8/24/17 4:21 PM		94.91
8/24/17 9:40 AM	85	95.39		8/24/17 4:22 PM		94.91
8/24/17 10:40 AM	85	95.40		8/24/17 4:32 PM		94.91
8/24/17 11:40 PM	85	95.40		8/24/17 4:42 PM		94.91
8/24/17 12:40 PM	85	95.40		8/24/17 4:52 PM		94.90
8/24/17 1:40 PM	85	95.40		8/24/17 5:02 PM		94.90

Well depth:	155'	Top of pipe
Static:	84.7'	Top of pipe
Well screen:	4"x30'x.012 st/st	
Pump length:	42.8"	
Motor length:	27.7"	

5 Rayber Road
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Appendix E

Wick Loading Test Water Level Data

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32 Lots Hollow Loading Test
(BMW22 Reference)
30-Day Loading Test
Orleans, MA

Well ID	Distance from Wick (ft)	Elevation (ft MSL)*	(Static) Friday 2/9/2018 11:00	Friday 2/9/2018 15:00	Water Level Increase	Mound Height	Saturday 2/10/2018 8:00	Water Level Increase	Mound Height	Saturday 2/10/2018 18:00	Water Level Increase	Mound Height	Sunday 2/11/2018 9:30	Water Level Increase	Mound Height	Sunday 2/11/2018 20:00	Water Level Increase	Mound Height	Monday 2/12/2018 8:00	Water Level Increase	Mound Height	Monday 2/12/2018 17:00	Water Level Increase	Mound Height
Day			Start Load Test	1			2			2			3			3			4			4		
Meter			101,000										172,600											
Loading Rate			20	20			20			33			33			33			33			33		
Wick Well	0	123.3	103	103.00	0.00		99.45	-3.55		90.00	-13.00		91.32	-11.68		91.41	-11.59		92.68	-10.32		91.85	-11.15	
LH-1	5	124.3	109.39	109.37	0.02	0.03	109.33	0.06	0.03	108.93	0.46	0.43	108.72	0.67	0.61	108.74	0.65	0.59	108.71	0.68	0.60	108.64	0.75	0.67
LH-2	15	123.8	108.89	108.87	0.02	0.03	108.83	0.06	0.03	108.48	0.41	0.38	108.31	0.58	0.52	108.33	0.56	0.50	108.31	0.58	0.50	108.24	0.65	0.57
LH-3	30	123.0	108.08	108.06	0.02	0.03	108.03	0.05	0.02	107.78	0.30	0.27	107.62	0.46	0.40	107.66	0.42	0.36	107.64	0.44	0.36	107.58	0.50	0.42
LH-4	60	123.8	108.91	108.88	0.03	0.04	108.85	0.06	0.03	108.61	0.30	0.27	108.32	0.59	0.53	108.57	0.34	0.28	108.58	0.33	0.25	108.53	0.38	0.30
LH-5	125	119.8	104.99	104.96	0.03	0.04	104.92	0.07	0.04	104.75	0.24	0.21	104.71	0.28	0.22	104.80	0.19	0.13	104.84	0.15	0.07	104.79	0.20	0.12
MW-14	250	105.2	90.16	90.12	0.04	0.05	90.19	-0.03	-0.06	90.09	0.07	0.04	89.95	0.21	0.15	NM			90.10	0.06	-0.02	90.09	0.07	-0.01
MW-9	415	107.3	92.24	92.23	0.01	0.02	92.19	0.05	0.02	92.11	0.13	0.10	92.04	0.20	0.14	NM			92.17	0.07	-0.01	92.16	0.08	0.00
MW-15S	550	109.2	94.31	94.29	0.02	0.03	94.25	0.06	0.03	94.15	0.16	0.13	94.09	0.22	0.16	NM			94.22	0.09	0.01	94.22	0.09	0.01
CL-1	600	98.5	86.22	86.21	0.01	0.02	86.17	0.05	0.02	86.11	0.11	0.08	86.02	0.20	0.14	NM			86.18	0.04	-0.04	86.18	0.04	-0.04
MW-2D	640	103.6	89.52	89.48	0.04	0.05	89.45	0.07	0.04	89.40	0.12	0.09	89.33	0.19	0.13	NM			89.46	0.06	-0.02	89.45	0.07	-0.01
MW-16S	725	103.4	88.51	88.48	0.03	0.04	88.45	0.06	0.03	88.40	0.11	0.08	88.32	0.19	0.13	NM			88.44	0.07	-0.01	88.42	0.09	0.01
CL-2	735	85.4	72.80	72.77	0.03	0.04	72.73	0.07	0.04	72.68	0.12	0.09	72.61	0.19	0.13	NM			72.80	0.00	-0.08	72.78	0.02	-0.06
MW-5	825	103.6	88.63	88.61	0.02	0.03	88.56	0.07	0.04	88.51	0.12	0.09	88.44	0.19	0.13	NM			88.55	0.08	0.00	88.53	0.10	0.02
CL-3	860	85.8	73.14	73.13	0.01	0.02	73.09	0.05	0.02	73.04	0.10	0.07	72.95	0.19	0.13	NM			73.12	0.02	-0.06	73.11	0.03	-0.05
(Local Ave**)					0.02			0.06			0.11			0.19						0.05			0.06	
BMW 22 (Ambient)	8,275		30.34	30.35	-0.01		30.31	0.03		30.31	0.03		30.28	0.06		30.28	0.06		30.26	0.08		30.26	0.08	
Rainfall (in.)			0.00	0.00			0.18						1.68						0.23					
Rainfall (cum.)							0.18						1.86						2.09					

Notes:
*** MSL = mean sea level**
**** Average of closest, most distant wells. Likely outside of influence of loading.**
***** http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-69.9776#.WotKukYrK71**

Notes:

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Notes:

https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=414630070014901
https://maps.waterdata.usgs.gov/mapper/nwisquery.html?URL=https://waterdata.usgs.gov/ma/nwis/dv?referred_module=gw&county_cd=25001&format=sitefile_output&sitefile_output_format=xml&column_name=agency_cd&column_name=site_no&column_name=station_nm&range_selection=days&period=365&begin_date=2017-02-19&end_date=2018-02-18&date_format=YYYY-MM-DD
http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-69.9776#.WotKukYrK71

Loading Test	gpm	gpd	Days	Days Cummulative	LH-1 (5ft)	LH-2 (15ft)	LH-3 (30ft)	LH-4 (60 ft)	LH-5 (125 ft)	MW-14 (250 ft)	MW-9 (415 ft)	Wick Mound (ft Rise)	Wick Efficiency (gpm/ft)	Wick Efficiency (gpd/ft)
Loading	20	28,800	1	1	0.03	0.03	0.02	0.03	0.03	-0.06	0.02	3.55	0.18	8,113
	33	47,520	5	6	1.03	0.90	0.72	0.56	0.33	0.15	0.11	14.38	0.44	3,305
	56	80,640	4	10	1.85	1.60	1.31	1.04	0.48	0.11	0.07	17.95	0.32	4,492
	88	126,720	23	33	3.10	2.85	2.38	2.00	1.07	0.08	0.13	42.40	0.48	2,989
			33										0.41	3,595
Recovery	0		2											
Total			35											

Estimated WL in Wick						
	1-ft Diameter Wick			3-ft Diameter Wick		
Discharge Rate	Wick Efficiency (gpm/ft)	Wick Efficiency (gpd/ft)	Depth to Mound*	Wick Efficiency (gpm/ft)	Wick Efficiency (gpd/ft)	
150,000	3,500	43	57	6,000	25	75
200,000	3,500	57	43	6,000	33	67
350,000	3,500	100	0	6,000	58	42
400,000	3,500	114	-14	6,000	67	33
450,000	3,500	129	-29	6,000	75	25
500,000	3,500	143	-43	6,000	83	17

* Assumes wick installed to 100 ft depth and depth to water a minimum of 100 ft

32 Lots Hollow Loading Test
(BMW22 Reference)
30-Day Loading Test
Orleans, MA

Tuesday			Wednesday			Thursday			Friday			Saturday			Monday			Tuesday			Wednesday		
2/13/2018 15:30	Water Level Increase	Mound Height	2/14/2018 14:00	Water Level Increase	Mound Height	2/15/2018 13:30	Water Level Increase	Mound Height	2/16/2018 9:30	Water Level Increase	Mound Height	2/17/2018 8:00	Water Level Increase	Mound Height	2/19/2018 8:30	Water Level Increase	Mound Height	2/20/2018 8:00	Water Level Increase	Mound Height	2/21/2018 7:00	Water Level Increase	Mound Height
5			6			7			8			9			11			12			13		
			323,300			368,800			436,200			514,600			681,300			808,300			931,600		
33			33			34/60			59			56			58/90			89			87		
93.44	-9.56		90.25	-12.75		88.62	-14.38		85.10	-17.90		85.05	-17.95		86.50	-16.50		76.20	-26.80		72.20	-30.80	
108.60	0.79	0.68	108.25	1.14	0.98	108.14	1.25	1.03	107.73	1.66	1.38	107.48	1.91	1.59	107.16	2.23	1.85	106.50	2.89	2.39	106.20	3.19	2.64
108.20	0.69	0.58	107.92	0.97	0.81	107.77	1.12	0.90	107.43	1.46	1.18	107.21	1.68	1.36	106.91	1.98	1.60	106.33	2.56	2.06	106.03	2.86	2.31
107.53	0.55	0.44	107.22	0.86	0.70	107.14	0.94	0.72	106.88	1.20	0.92	106.70	1.38	1.06	106.39	1.69	1.31	105.95	2.13	1.63	105.65	2.43	1.88
108.49	0.42	0.31	108.21	0.70	0.54	108.13	0.78	0.56	107.93	0.98	0.70	107.80	1.11	0.79	107.49	1.42	1.04	107.15	1.76	1.26	106.88	2.03	1.48
104.77	0.22	0.11	104.53	0.46	0.30	104.44	0.55	0.33	104.38	0.61	0.33	104.35	0.64	0.32	104.13	0.86	0.48	103.98	1.01	0.51	103.87	1.12	0.57
90.09	0.07	-0.04	89.80	0.36	0.20	89.79	0.37	0.15	89.75	0.41	0.13	89.78	0.38	0.06	89.67	0.49	0.11	89.62	0.54	0.04	89.59	0.57	0.02
92.15	0.09	-0.02	91.94	0.30	0.14	91.91	0.33	0.11	91.85	0.39	0.11	91.86	0.38	0.06	91.79	0.45	0.07	91.73	0.51	0.01	91.69	0.55	0.00
94.21	0.10	-0.01	94.01	0.30	0.14	93.97	0.34	0.12	93.93	0.38	0.10	93.94	0.37	0.05	93.85	0.46	0.08	93.79	0.52	0.02	93.73	0.58	0.03
86.20	0.02	-0.09	85.97	0.25	0.09	85.92	0.30	0.08	85.91	0.31	0.03	85.95	0.27	-0.05	85.92	0.30	-0.08	85.85	0.37	-0.13	85.81	0.41	-0.14
89.45	0.07	-0.04	89.08	0.44	0.28	89.11	0.41	0.19	89.14	0.38	0.10	89.17	0.35	0.03	89.10	0.42	0.04	89.04	0.48	-0.02	88.99	0.53	-0.02
88.41	0.10	-0.01	88.18	0.33	0.17	88.16	0.35	0.13	88.11	0.40	0.12	88.13	0.38	0.06	88.07	0.44	0.06	88.03	0.48	-0.02	87.99	0.52	-0.03
72.80	0.00	-0.11	72.49	0.31	0.15	72.46	0.34	0.12	72.48	0.32	0.04	72.52	0.28	-0.04	72.46	0.34	-0.04	72.45	0.35	-0.15	72.40	0.40	-0.15
88.52	0.11	0.00	88.29	0.34	0.18	88.25	0.38	0.16	88.20	0.43	0.15	88.23	0.40	0.08	88.17	0.46	0.08	88.11	0.52	0.02	88.05	0.58	0.03
73.13	0.01	-0.10	72.89	0.25	0.09	72.87	0.27	0.05	72.86	0.28	0.00	72.92	0.22	-0.10	72.87	0.27	-0.11	72.85	0.29	-0.21	72.80	0.34	-0.21
	0.06			0.29			0.32			0.35			0.31			0.36			0.41			0.46	
30.23	0.11		30.18	0.16		30.12	0.22		30.06	0.28		30.02	0.32		29.96	0.38		29.84	0.50		29.79	0.55	
0.00			0.01			0.14			0.26			0.10			0.33			0.01			0.00		
2.09			2.10			2.24			2.50			2.60			2.93			2.94			2.94		
Notes:			**Notes:**			**Notes:** Increase Discharge Rate to 60 gpm Add Gravel			**Notes:** Add Gravel			**Notes** Download Loggers Logger caught in stone in 2-inch PVC Gravel @ 90.5 ftinto 2-inch PVC Add Gravel			**Notes** Increase Discharge Rate to 90 gpm Add Gravel Gravel in 2" PVC at 83.8f ft. Gravel appears to be moving from 8" to 2" PVC Gravel in 8-inch 2 .90 ft			**Notes:** Move logger from MW-15S to wick Gravel in 2" PVC at 83.8f ft Gravel in 8-inch 2.90 ft			**Notes:** Gravel in 2" PVC at 77.7f ft Gravel in 8-inch @ 3.30 ft Gravel washing from outside of 2-inch PCV to inside		

2&rdb_compression=file&list_of_search_criteria=county_cd%2Crealtime_parameter_selection&column_name=site_tp_cd&column_name=dec_lat_va&column_name=dec_long_va&column_name=agency_use_cd

32 Lots Hollow Loading Test
(BMW22 Reference)
30-Day Loading Test
Orleans, MA

Thursday			Saturday			Sunday			Monday			Tuesday			Wednesday			Thursday			Friday		
2/22/2018 16:30	Water Level Increase	Mound Height	2/24/2018 10:00	Water Level Increase	Mound Height	2/25/2018 9:50	Water Level Increase	Mound Height	2/26/2018 16:00	Water Level Increase	Mound Height	2/27/2018 6:30	Water Level Increase	Mound Height	2/28/2018	Water Level Increase	Mound Height	3/1/2018	Water Level Increase	Mound Height	3/2/2018	Water Level Increase	Mound Height
14			16			17			18			19			20			21			22		
1,057,400			1,318,300			1,452,200			1,569,900			1,689,400						1,968,800			2,114,300		
87			87			87			88			88			88			88.00			89.00		
NM			66.72	-36.28		NM			NM			67.50	-35.50		66.90	-36.10		67.20	-35.80				
106.00	3.39	2.80	105.68	3.71	3.07	NM			105.58	3.81	3.03	105.50	3.89	3.07	105.54	3.85	2.99	105.45	3.94	3.04	NM		
105.88	3.01	2.42	105.54	3.35	2.71	NM			105.42	3.47	2.69	105.39	3.50	2.68	105.37	3.52	2.66	105.28	3.61	2.71	NM		
105.42	2.66	2.07	105.14	2.94	2.30	NM			105.02	3.06	2.28	105.00	3.08	2.26	105.00	3.08	2.22	104.90	3.18	2.28	NM		
106.69	2.22	1.63	106.39	2.52	1.88	NM			106.24	2.67	1.89	106.15	2.76	1.94	106.21	2.70	1.84	106.13	2.78	1.88	NM		
103.65	1.34	0.75	103.41	1.58	0.94	NM			103.23	1.76	0.98	103.16	1.83	1.01	103.22	1.77	0.91	103.16	1.83	0.93	NM		
NM			89.34	0.82	0.18	NM			89.21	0.95	0.17	NM			89.25	0.91	0.05	89.20	0.96	0.06	NM		
NM			91.40	0.84	0.20	NM			91.28	0.96	0.18	NM			91.31	0.93	0.07	91.25	0.99	0.09	NM		
NM			93.48	0.83	0.19	NM			93.37	0.94	0.16	NM			93.38	0.93	0.07	93.33	0.98	0.08	NM		
NM			85.70	0.52	-0.12	NM			85.62	0.60	-0.18	NM			85.67	0.55	-0.31	85.61	0.61	-0.29	NM		
NM			88.82	0.70	0.06	NM			88.73	0.79	0.01	NM			88.76	0.76	-0.10	88.63	0.89	-0.01	NM		
NM			87.78	0.73	0.09	NM			87.69	0.82	0.04	NM			87.72	0.79	-0.07	87.68	0.83	-0.07	NM		
NM			72.27	0.53	-0.11	NM			72.20	0.60	-0.18	NM			72.24	0.56	-0.30	72.20	0.60	-0.30	NM		
NM			87.89	0.74	0.10	NM			87.80	0.83	0.05	NM			87.85	0.78	-0.08	87.81	0.82	-0.08	NM		
NM			72.70	0.44	-0.20	NM			72.65	0.49	-0.29	NM			72.71	0.43	-0.43	72.68	0.46	-0.44	NM		
				0.59						0.66						0.61			0.64				
29.75	0.59		29.70	0.64		29.60	0.74		29.56	0.78		29.52	0.82		29.48	0.86		29.44	0.90		29.38	0.96	
0.03			0.22			0.59			0.01			0.00			0.00			0.00			2.41		
2.97			3.19			3.78			3.79			3.79			3.79			3.79			6.20		
Notes: Gravel in 8-inch @ 3.30 ft			**Notes:** Gravel in 8-inch @ 3.80 ft			**Notes:**			**Notes:** Gravel in 8-inch @ 3.80 ft			**Notes:**			**Notes:** Gravel in 2" PVC at 76.9 f ft Gravel in 8-inch @ 4.60 ft			**Notes:**			**Notes:**		

32 Lots Hollow Loading Test
(BMW22 Reference)
30-Day Loading Test
Orleans, MA

Saturday			Sunday			Monday			Tuesday			Wednesday			Thursday			Friday			Saturday		
3/3/2018 9:00	Water Level Increase	Mound Height	3/4/2018 11:00	Water Level Increase	Mound Height	3/5/2018	Water Level Increase	Mound Height	3/6/2018 9:30	Water Level Increase	Mound Height	3/7/2018	Water Level Increase	Mound Height	3/8/2018 10:30	Water Level Increase	Mound Height	3/9/2018	Water Level Increase	Mound Height	3/10/2018	Water Level Increase	Mound Height
23			24			25			26			27			28			29			30		
2,214,600						2,466,800			2,605,800			2,717,300						2,974,000			3,133,600		
89.00			88			89			88			88						88					
67.50	-35.50		65.95	-37.05		67.50	-35.50		65.65	-37.35		63.20	-39.80		62.30	-40.70		66.10	-36.90		65.50	-37.50	
105.28	4.11	3.10	105.20	4.19	3.12	105.16	4.23	3.10	105.21	4.18	2.99	105.01	4.38	3.13	104.97	4.42	3.09	104.89	4.50	3.11	104.80	4.59	3.15
105.04	3.85	2.84	105.02	3.87	2.80	104.91	3.98	2.85	105.02	3.87	2.68	104.82	4.07	2.82	104.77	4.12	2.79	104.69	4.20	2.81	104.62	4.27	2.83
104.65	3.43	2.42	104.63	3.45	2.38	104.53	3.55	2.42	104.64	3.44	2.25	104.41	3.67	2.42	104.38	3.70	2.37	104.30	3.78	2.39	104.22	3.86	2.42
105.87	3.04	2.03	105.87	3.04	1.97	105.81	3.10	1.97	105.89	3.02	1.83	105.65	3.26	2.01	105.87	3.04	1.71	105.58	3.33	1.94	105.51	3.40	1.96
102.96	2.03	1.02	102.89	2.10	1.03	102.84	2.15	1.02	102.88	2.11	0.92	102.72	2.27	1.02	102.66	2.33	1.00	102.54	2.45	1.06	102.54	2.45	1.01
NM			88.96	1.20	0.13	NM			88.95	1.21	0.02	NM			88.76	1.40	0.07	NM			88.62	1.54	0.10
NM			91.00	1.24	0.17	NM			91.00	1.24	0.05	NM			90.77	1.47	0.14	NM			89.98	2.26	0.82
NM			93.08	1.23	0.16	NM			92.71	1.60	0.41	NM			92.88	1.43	0.10	NM			92.71	1.60	0.16
NM			85.46	0.76	-0.31	NM			85.42	0.80	-0.39	NM			85.27	0.95	-0.38	NM			85.13	1.09	-0.35
NM			88.49	1.03	-0.04	NM						NM			88.30	1.22	-0.11	NM			88.12	1.40	-0.04
NM			87.42	1.09	0.02	NM			87.41	1.10	-0.09	NM			87.20	1.31	-0.02	NM			87.05	1.46	0.02
NM			72.02	0.78	-0.29	NM			72.04	0.76	-0.43	NM			71.90	0.90	-0.43	NM			71.75	1.05	-0.39
NM			87.52	1.11	0.04	NM			87.51	1.12	-0.07	NM			87.29	1.34	0.01	NM			87.06	1.57	0.13
NM			72.52	0.62	-0.45	NM			72.56	0.58	-0.61	NM			72.41	0.73	-0.60	NM			72.31	0.83	-0.61
				0.87						0.85						1.04						1.20	
29.33	1.01		29.27	1.07		29.21	1.13		29.15	1.19		29.09	1.25		29.01	1.33		28.95	1.39		28.90	1.44	
0.18			0.03			0.21			0.01			0.69			0.14			0.00			0.00		
6.38			6.41			6.62			6.63			7.32			7.46			7.46			7.46		
Notes:			Notes:			Notes:			Notes:			Notes:			Notes:			Notes:			Notes:		

32 Lots Hollow Loading Test
(BMW22 Reference)
30-Day Loading Test
Orleans, MA

Sunday			Monday			(Shutdown) Wednesday			Thursday			Friday			Saturday			Sunday			Monday			Tuesday		
3/11/2018	Water Level Increase	Mound Height	3/12/2018	Water Level Increase	Mound Height	3/14/2018 14:00	Water Level Increase	Mound Height	3/15/2018 10:30	Water Level Increase	Mound Height	3/17/2018 8:30	Water Level Increase	Mound Height	3/18/2018 8:30	Water Level Increase	Mound Height	3/19/2018	Water Level Increase	Mound Height	3/26/2018 15:00	Water Level Increase	Mound Height	3/27/2018 15:00	Water Level Increase	Mound Height
31			32			34 (Shutdown)			1			3			4			5								
3,230,500			3,403,000																							
87			92			0			0			0			0			0			0			0		
64.50	-38.50		60.60	-42.40		63.36	-39.64		Dry			Dry			Dry			Dry			Dry			Dry		
104.79	4.60	3.11	104.75	4.64	3.10	104.64	4.75	3.07	105.97	3.42	1.68	106.54	2.85	1.02	107.00	2.39	0.51	107.13	2.26	0.33	107.29	2.10	-0.12	107.22	2.17	-0.01
104.60	4.29	2.80	104.50	4.39	2.85	104.44	4.45	2.77	105.57	3.32	1.58	106.10	2.79	0.96	106.58	2.31	0.43	106.65	2.24	0.31	106.80	2.09	-0.13			
104.20	3.88	2.39	104.16	3.92	2.38	104.04	4.04	2.36	104.89	3.19	1.45	105.34	2.74	0.91	105.77	2.31	0.43	105.88	2.20	0.27	105.99	2.09	-0.13			
105.47	3.44	1.95	105.37	3.54	2.00	105.24	3.67	1.99	105.86	3.05	1.31	106.22	2.69	0.86	106.54	2.37	0.49	106.68	2.23	0.30	106.80	2.11	-0.11			
102.43	2.56	1.07	102.38	2.61	1.07	102.26	2.73	1.05	102.40	2.59	0.85	102.62	2.37	0.54	102.82	2.17	0.29	102.82	2.17	0.24	102.81	2.18	-0.04			
NM			NM			88.40	1.76	0.08	88.41	1.75	0.01	88.42	1.74	-0.09	NM			88.36	1.80	-0.13	88.22	1.94	-0.28			
NM			NM			90.43	1.81	0.13	90.38	1.86	0.12	90.37	1.87	0.04	NM			90.32	1.92	-0.01	90.18	2.06	-0.16			
NM			NM			92.51	1.80	0.12	92.48	1.83	0.09	92.47	1.84	0.01	NM			92.43	1.88	-0.05	92.29	2.02	-0.20			
NM			NM			NM			84.94	1.28	-0.46	84.85	1.37	-0.46	NM			84.70	1.52	-0.41	84.47	1.75	-0.47	84.39	1.83	-0.35
NM			NM			87.97	1.55	-0.13	87.94	1.58	-0.16	87.92	1.60	-0.23	NM			87.81	1.71	-0.22	87.59	1.93	-0.29			
NM			NM			86.66	1.85	0.17	86.82	1.69	-0.05	86.78	1.73	-0.10	NM			86.69	1.82	-0.11	86.51	2.00	-0.22			
NM			NM			NM			71.53	1.27	-0.47	71.52	1.28	-0.55	NM			71.36	1.44	-0.49	71.13	1.67	-0.55	71.03	1.77	-0.41
NM			NM			86.86	1.77	0.09	86.92	1.71	-0.03	86.88	1.75	-0.08	NM			86.80	1.83	-0.10	86.59	2.04	-0.18			
NM			NM			NM			72.10	1.04	-0.70	72.09	1.05	-0.78	NM			71.93	1.21	-0.72	71.66	1.48	-0.74	71.58	1.56	-0.62
										1.38			1.40						1.52			1.76				
28.85	1.49		28.80	1.54		28.66	1.68		28.60	1.74		28.51	1.83		28.46	1.88		28.41	1.93		28.12	2.22		28.16	2.18	
0.00			0.00			1.36			0.10			0.00			0.00			0.00			0.80			0.00		
7.46			7.46			8.82			8.92			8.92			8.92			8.92			9.72			9.72		
Notes:			**Notes:**			**Notes:** Test shutdown at 13:15 Test shut down by Town, no loading rate and final wick reading available. Download Data Loggers Gravel in 2" PVC at 66.7 f ft Gravel in 8-inch @ 5.0 ft Wick WL 63.36 @ 2:05 Wick WL 65.75 @ 2:55 Wick WL dropping approx 3 ft/hr.			**Notes:** Gravel in 2" PVC at 66.7 f ft Gravel in 8-inch @ 5.0 ft			**Notes:**			**Notes:**			**Notes:**			**Notes:**			**Notes:** Remove Data Loggers frim Wick Download Pressure Transducer Data Move Data Loggers LH-2, L-3, LH-5 Wick 1 and Wick 2. Secure Wick Remove Hose		

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Appendix F

Ambient Well Water Level Data

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---------------------------------- WARNING --
Some of the data that you have obtained from this U.S. Geological Survey database
may not have received Director's approval. Any such data values are qualified
as provisional and are subject to revision. Provisional data are released on the
condition that neither the USGS nor the United States Government may be held liable
for any damages resulting from its use.
#
Additional info: https://help.waterdata.usgs.gov/policies/provisional-data-statement
#
File-format description: https://help.waterdata.usgs.gov/faq/about-tab-delimited-output
Automated-retrieval info: https://help.waterdata.usgs.gov/faq/automated-retrievals
#
Contact: gs-w_support_nwisweb@usgs.gov
retrieved: 2018-06-06 06:22:08 EDT   (caww01)
#
Data for the following 1 site(s) are contained in this file
USGS 414630070014901 MA-BMW   22 BREWSTER, MA

#
Data provided for site 414630070014901
TS   parameter   statistic   Description
65166   72019   00003   Depth to water level, feet below land surface (Mean)
00   72019   00011   Depth to water level, feet below land surface (Instantaneous)
#
Data-value qualification codes included in this output:
#
A Approved for publication -- Processing and review completed.
P Provisional data subject to revision.
#
Discrete groundwater status codes included in this output:
'00_72019_00011_cd'
#
""   The reported water-level measurement represents a static level
#
A   Approved for publication -- Processing and review completed.
P   Provisional data subject to revision.
#

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USGS	414630070014901	2018-04-04		27.94	P		
USGS	414630070014901	2018-04-04	15:35	EDT		27.92	:P
USGS	414630070014901	2018-04-05		27.95	P		
USGS	414630070014901	2018-04-06		27.93	P		
USGS	414630070014901	2018-04-07		27.91	P		
USGS	414630070014901	2018-04-08		27.91	P		
USGS	414630070014901	2018-04-09		27.93	P		
USGS	414630070014901	2018-04-10		27.93	P		
USGS	414630070014901	2018-04-11		27.92	P		
USGS	414630070014901	2018-04-12		27.91	P		
USGS	414630070014901	2018-04-13		27.91	P		
USGS	414630070014901	2018-04-14		27.94	P		
USGS	414630070014901	2018-04-15		27.98	P		
USGS	414630070014901	2018-04-16		27.92	P		
USGS	414630070014901	2018-04-17		27.90	P		
USGS	414630070014901	2018-04-18		27.92	P		
USGS	414630070014901	2018-04-19		27.93	P		
USGS	414630070014901	2018-04-20		27.97	P		
USGS	414630070014901	2018-04-21		28.00	P		
USGS	414630070014901	2018-04-22		28.03	P		
USGS	414630070014901	2018-04-23		28.05	P		
USGS	414630070014901	2018-04-24		28.05	P		
USGS	414630070014901	2018-04-25		28.01	P		
USGS	414630070014901	2018-04-26		27.99	P		
USGS	414630070014901	2018-04-27		28.02	P		
USGS	414630070014901	2018-04-28		28.03	P		
USGS	414630070014901	2018-04-29		28.04	P		
USGS	414630070014901	2018-04-30		28.06	P		
USGS	414630070014901	2018-05-01		28.07	P		
USGS	414630070014901	2018-05-02		28.08	P		
USGS	414630070014901	2018-05-03		28.08	P		
USGS	414630070014901	2018-05-04		28.09	P		
USGS	414630070014901	2018-05-05		28.12	P		
USGS	414630070014901	2018-05-06		28.12	P		
USGS	414630070014901	2018-05-07		28.14	P		
USGS	414630070014901	2018-05-08		28.16	P		
USGS	414630070014901	2018-05-09		28.17	P		
USGS	414630070014901	2018-05-10		28.15	P		
USGS	414630070014901	2018-05-11		28.18	P		
USGS	414630070014901	2018-05-12		28.20	P		
USGS	414630070014901	2018-05-13		28.21	P		
USGS	414630070014901	2018-05-14		28.20	P		
USGS	414630070014901	2018-05-15		28.20	P		
USGS	414630070014901	2018-05-16		28.23	P		
USGS	414630070014901	2018-05-17		28.23	P		
USGS	414630070014901	2018-05-18		28.26	P		
USGS	414630070014901	2018-05-19		28.25	P		
USGS	414630070014901	2018-05-20		28.23	P		
USGS	414630070014901	2018-05-21		28.27	P		
USGS	414630070014901	2018-05-22		28.28	P		
USGS	414630070014901	2018-05-23		28.27	P		
USGS	414630070014901	2018-05-24		28.30	P		
USGS	414630070014901	2018-05-25		28.30	P		
USGS	414630070014901	2018-05-26		28.31	P		
USGS	414630070014901	2018-05-27		28.34	P		
USGS	414630070014901	2018-05-28		28.35	P		
USGS	414630070014901	2018-05-29		28.36	P		
USGS	414630070014901	2018-05-30		28.38	P		
USGS	414630070014901	2018-05-31		28.39	P		
USGS	414630070014901	2018-06-01		28.39	P		
USGS	414630070014901	2018-06-02		28.41	P		
USGS	414630070014901	2018-06-03		28.43	P		

Appendix G

Precipitation Data

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MONTHLY CLIMATOLOGICAL SUMMARY for FEB. 2018

NAME: rain history CITY: STATE:
ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	39.9	45.4	2:00p	33.8	12:30a	25.1	0.0	0.03	2.5	22.0	12:30p	SSW
2	29.5	41.2	4:30a	16.6	12:00m	35.5	0.0	0.13	5.5	26.0	11:00p	W
3	21.6	30.4	12:00m	13.6	5:00a	43.4	0.0	0.00	3.6	21.0	1:00a	W
4	41.0	47.5	7:30p	30.4	12:30a	24.0	0.0	0.69	5.9	25.0	3:00p	SSE
5	39.9	51.7	3:00a	29.1	12:00m	25.1	0.0	0.26	4.8	26.0	3:30a	W
6	30.5	35.0	3:30p	25.5	4:00a	34.5	0.0	0.00	0.1	11.0	2:30p	W
7	37.9	52.0	5:30p	24.4	7:00a	27.1	0.0	0.76	3.9	32.0	5:30p	ESE
8	28.7	37.1	12:30a	23.2	8:00p	36.3	0.0	0.02	4.1	24.0	4:00a	W
9	29.8	34.7	12:00m	25.4	7:00a	35.2	0.0	0.00	1.7	15.0	2:00p	W
10	47.8	54.0	11:30p	34.6	12:30a	17.2	0.0	0.18	5.3	25.0	12:30p	SSE
11	50.2	55.6	5:30p	44.5	3:00p	14.8	0.0	1.68	1.4	25.0	9:00p	SSW
12	42.3	54.7	2:00a	29.9	9:30p	22.7	0.0	0.23	1.1	26.0	2:00a	W
13	30.7	34.8	12:30a	27.9	7:00a	34.3	0.0	0.00	1.2	18.0	5:00a	W
14	38.9	47.9	2:30p	29.7	12:30a	26.1	0.0	0.01	0.8	17.0	1:30p	SSW
15	43.4	46.7	4:30p	38.6	1:00a	21.6	0.0	0.14	0.9	17.0	10:30p	SSW
16	46.4	52.4	12:30p	36.1	12:00m	18.6	0.0	0.26	2.5	23.0	12:00m	W
17	34.4	37.6	12:00m	29.9	6:30a	30.6	0.0	0.10	2.9	25.0	12:30a	SE
18	36.8	41.5	5:00a	28.7	11:30p	28.2	0.0	0.29	3.4	28.0	8:00a	W
19	41.8	49.1	10:00p	26.7	3:00a	23.2	0.0	0.04	2.7	21.0	10:30p	SSE
20	50.3	57.0	2:30p	47.3	7:30p	14.7	0.0	0.01	4.4	26.0	1:00p	SSW
21	51.5	57.2	10:00p	48.8	11:30p	13.5	0.0	0.00	3.2	26.0	2:00a	SSW
22	40.6	51.1	1:00a	33.4	7:30p	24.4	0.0	0.03	1.1	18.0	5:30p	NE
23	39.0	43.0	11:00p	34.9	1:30a	26.0	0.0	0.09	3.6	20.0	8:30p	SE
24	46.1	53.1	1:30p	39.9	1:00a	18.9	0.0	0.13	2.1	19.0	6:00a	W
25	41.4	44.3	7:30p	38.8	7:30a	23.6	0.0	0.59	4.4	26.0	2:30p	ESE
26	41.2	47.4	4:00p	37.5	7:00a	23.8	0.0	0.01	1.3	15.0	4:00a	W
27	41.0	48.9	3:30p	35.5	5:30a	24.0	0.0	0.00	1.1	14.0	11:30p	W
28	45.7	53.1	1:00p	40.0	6:00a	19.3	0.0	0.00	3.5	31.0	12:30p	SSW
	39.6	57.2	21	13.6	3	711.7	0.0	5.68	2.8	32.0	7	W

Max >= 90.0: 0
Max <= 32.0: 1
Min <= 32.0: 14
Min <= 0.0: 0
Max Rain: 1.68 ON 02/11/18
Days of Rain: 18 (>.01 in) 12 (>.1 in) 1 (>1 in)
Heat Base: 65.0 Cool Base: 65.0 Method: Integration

SNOW = 0.50"
$\bar{X}H = 46.6°$
$\bar{X}L = 32.3°$

MONTHLY CLIMATOLOGICAL SUMMARY for JAN. 2018

NAME: rain history CITY: STATE:
ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	11.9	15.1	3:30p	8.8	7:30a	53.1	0.0	0.00	6.6	21.0	9:30p	W
2	15.2	18.8	12:00m	12.8	12:30a	49.8	0.0	0.00	3.8	20.0	9:30a	W
3	25.0	32.6	3:00p	14.7	7:00a	40.0	0.0	0.00	1.1	16.0	1:00p	SSE
4	36.3	43.1	7:30a	25.4	12:00m	28.7	0.0	1.01	7.5	40.0	6:00p	NE
5	17.3	25.6	1:00a	9.8	10:30p	47.7	0.0	0.00	8.0	27.0	6:00p	W
6	11.5	15.6	2:30p	8.8	7:00a	53.5	0.0	0.00	8.3	28.0	7:00p	W
7	12.1	25.2	12:00m	6.5	4:00a	52.9	0.0	0.00	3.5	23.0	2:00a	W
8	34.9	41.3	7:00p	25.2	12:30a	30.1	0.0	0.02	5.6	30.0	8:00p	SSW
9	35.8	41.0	12:30p	31.0	12:00m	29.2	0.0	0.01	3.7	19.0	12:30a	W
10	33.7	39.4	12:30p	26.3	7:30a	31.3	0.0	0.00	1.5	14.0	12:30a	SSE
11	46.4	53.4	11:00a	35.4	12:30a	18.6	0.0	0.00	3.8	27.0	10:30p	SSE
12	54.4	58.1	1:00p	51.3	1:00a	10.6	0.0	0.19	9.0	33.0	1:00p	SSE
13	44.4	56.3	2:30a	27.6	12:00m	20.6	0.0	0.14	7.2	37.0	4:30a	SSE
14	26.4	27.8	2:00p	24.5	6:00p	38.6	0.0	0.00	2.5	15.0	2:00a	W
15	31.7	35.0	11:00a	27.4	12:30a	33.3	0.0	0.00	1.5	18.0	8:00a	NE
16	32.0	38.2	1:00p	28.7	7:00p	33.0	0.0	0.03	0.1	10.0	12:30a	NNW
17	35.1	38.5	4:00p	31.2	12:30a	29.9	0.0	0.36	0.4	12.0	10:00a	NW
18	31.1	33.4	12:30a	29.0	5:00p	33.9	0.0	0.00	1.5	16.0	5:00p	W
19	29.4	33.6	12:30p	25.8	7:30a	35.6	0.0	0.00	1.8	12.0	12:30a	W
20	42.2	50.6	3:00p	29.7	2:00a	22.8	0.0	0.00	2.5	38.0	9:30a	W
21	38.5	45.9	2:30p	31.5	9:30p	26.5	0.0	0.00	0.5	12.0	12:00p	W
22	38.9	42.5	12:00m	32.3	2:30a	26.1	0.0	0.02	1.6	18.0	8:30p	SE
23	49.2	54.6	4:30p	42.5	12:30a	15.8	0.0	0.63	7.4	32.0	4:30p	SSE
24	37.8	45.0	12:30a	28.8	12:00m	27.2	0.0	0.00	2.9	18.0	11:00a	W
25	26.5	29.4	3:30p	23.0	6:00a	38.5	0.0	0.00	6.6	24.0	9:00p	W
26	25.4	30.5	3:00p	20.6	9:00p	39.6	0.0	0.00	3.8	28.0	4:00a	W
27	41.1	48.8	2:30p	26.2	12:30a	23.9	0.0	0.00	5.1	31.0	10:00p	SSE
28	45.3	47.9	12:00p	39.5	12:00m	19.7	0.0	0.21	1.5	23.0	2:00a	SSW
29	39.5	42.3	11:00a	36.4	7:30p	25.5	0.0	0.03	3.4	28.0	11:00p	NE
30	29.2	37.0	12:30a	25.7	3:00p	35.8	0.0	0.04	5.3	27.0	2:00a	W
31	25.6	33.8	12:00m	21.6	6:30a	39.4	0.0	0.02	3.9	22.0	1:00a	W
	32.4	58.1	12	6.5	7	1011.2	0.0	2.71	3.9	40.0	4	W

Max >= 90.0: 0
Max <= 32.0: 8
Min <= 32.0: 25
Min <= 0.0: 0
Max Rain: 1.01 ON 01/04/18
Days of Rain: 12 (>.01 in) 6 (>.1 in) 1 (>1 in)
Heat Base: 65.0 Cool Base: 65.0 Method: Integration

$\bar{x}H = 38.1^{0}$

$\bar{x}L = 26^{0}$

$SNOW = 8.75''$

MONTHLY CLIMATOLOGICAL SUMMARY for MAR. 2018

NAME: rain history CITY: STATE:
ELEV: 54 ft LAT: 41° 07' 01" N LONG: 69° 09' 01" W

TEMPERATURE (°F), RAIN (in), WIND SPEED (mph)

DAY	MEAN TEMP	HIGH	TIME	LOW	TIME	HEAT DEG DAYS	COOL DEG DAYS	RAIN	AVG WIND SPEED	HIGH	TIME	DOM DIR
1	46.6	57.3	1:30p	41.7	8:30p	18.4	0.0	0.00	0.8	17.0	11:30p	NE
2	42.6	47.1	9:30a	37.5	11:30p	22.4	0.0	2.41	8.4	45.0	5:30p	NE
3	40.4	42.2	9:30a	36.9	1:00a	24.6	0.0	0.18	6.2	40.0	2:00a	NE
4	38.1	41.1	1:30a	35.9	11:30p	26.9	0.0	0.03	2.6	26.0	1:30a	NE
5	38.7	41.4	2:30p	35.0	3:00a	26.3	0.0	0.21	4.4	31.0	9:30a	NE
6	36.6	41.0	12:00p	34.4	8:30a	28.4	0.0	0.01	1.5	19.0	12:30a	NE
7	39.6	44.3	12:00m	35.4	12:30a	25.4	0.0	0.69	3.8	36.0	10:30p	ESE
8	37.9	44.3	12:30a	33.4	10:00a	27.1	0.0	0.14	3.0	26.0	9:00a	W
9	34.9	39.5	11:00a	29.6	6:00a	30.1	0.0	0.00	1.4	18.0	11:00a	W
10	37.3	42.2	12:30p	33.5	4:30a	27.7	0.0	0.00	5.1	22.0	12:30p	W
11	37.5	42.4	2:30p	32.6	6:00a	26.3	0.0	0.00	3.2	18.0	11:00a	W
12	38.1	45.2	2:30p	28.8	7:00a	26.9	0.0	0.00	1.2	21.0	11:30p	ESE
13	33.8	40.3	12:30a	32.2	12:00m	31.2	0.0	0.76	6.5	31.0	2:00a	NE
14	33.9	38.2	3:00p	29.3	4:30a	31.1	0.0	0.62	2.5	30.0	12:30p	SSW
15	36.8	42.3	4:30p	31.7	6:30a	28.3	0.0	0.10	4.0	20.0	10:00a	W
16	34.4	37.0	12:30a	30.2	12:00m	30.6	0.0	0.00	6.9	25.0	8:30p	W
17	31.8	40.9	4:30p	25.3	12:00m	33.2	0.0	0.00	6.3	23.0	12:30a	W
18	27.0	31.5	4:30p	22.8	7:00a	38.1	0.0	0.00	4.4	24.0	4:30p	W
19	30.2	35.8	5:30p	25.3	7:00a	34.8	0.0	0.00	5.6	25.0	10:00a	W
20	33.2	37.9	3:00p	27.9	7:00a	31.8	0.0	0.00	1.3	15.0	12:30a	W
21	37.3	39.1	3:00a	35.0	2:00p	27.7	0.0	0.26	4.4	29.0	11:00p	NE
22	35.7	38.6	9:30p	33.9	7:00a	29.3	0.0	0.50	4.6	27.0	6:00a	NE
23	37.4	43.2	1:30p	29.9	12:00m	27.6	0.0	0.00	1.2	13.0	3:00p	W
24	37.8	46.0	3:30p	28.2	5:00a	27.2	0.0	0.00	0.9	16.0	11:00a	W
25	35.8	38.5	3:30p	32.9	6:30p	29.2	0.0	0.02	2.5	25.0	3:00p	NE
26	36.0	39.8	1:00p	33.9	7:30p	29.0	0.0	0.00	2.9	22.0	4:30p	NE
27	38.9	44.8	1:00p	34.4	1:00a	26.1	0.0	0.00	1.8	19.0	11:30a	NE
28	42.1	50.5	3:30p	37.4	12:00m	23.0	0.0	0.00	1.1	15.0	2:00p	W
29	44.8	54.4	1:30p	35.1	7:00a	20.2	0.0	0.00	1.8	17.0	11:00p	SSE
30	50.3	53.9	12:00p	44.2	11:00p	14.7	0.0	0.02	3.2	27.0	5:30a	SSW
31	42.3	48.1	2:00p	39.2	10:30p	22.7	0.0	0.01	3.1	21.0	8:00p	W
	37.7	57.3	1	22.8	18	846.3	0.0	5.96	3.4	45.0	2	W

Max >= 90.0: 0
Max <= 32.0: 1
Min <= 32.0: 11
Min <= 0.0: 0
Max Rain: 2.41 ON 03/02/18
Days of Rain: 13 (>.01 in) 9 (>.1 in) 1 (>1 in)
Heat Base: 65.0 Cool Base: 65.0 Method: Integration

$\bar{x}H = 42.9^{\circ}$
$\bar{x}L = 33.0^{\circ}$

DAY	WEATHER	TEMP.° F	WIND speed	WIND gust	WIND direction	BAROMETER inches	RAINFALL inches	SNOW inches	RELATIVE HUMIDITY %	APRIL 2018 REMARKS
1		57.0		24						H-53.0 L-39.2
2		40.5		17			.25			H-40.5 L-30.2
3		43.2		20			.34			H-43.2 L-27.5
4		56.4		31			.08			H-56.4 L-41.2
5		43.3		25						H-43.3 L-33.1
6		49.3		29			.20			H-49.3 L-28.7
7		48.9		16			.04			H-48.9 L-36.8
8		41.2		22						H-41.2 L-34.0
9		42.5		20						H-42.5 L-32.1
10		40.8		13			.05			H-40.8 L-30.9
11		44.6		15			.01			H-44.6 L-29.5
12		52.8		21			.02			H-52.8 L-36.8
13		54.3		39			.01			H-54.3 L-47.3
14		52.8		22						H-52.8 L-40.7
15	Cldy	38.0	3		NE	30.41			67/28	H-40.7 L-35
16	Cldy	41.1	13		ENE	30.16			97/40	H-52 L-36
17	PC	43.6	<1	13	SSW	29.48			94/42	H-53 L-42
18	Clear	37.9	2	20	WSW	29.64			80/32	H-51 L-37
19	RAIN	42	<1	18	SW	29.76	.24		90/42	H-42.7 L-37.8
20	MC	38	4	22	WSW	29.89	.01		82/33	H-41.7 L-38.1
21	Clear	41	4	16	W	30.25			76/34	H-52 L-38
22	Clear	41	<1	13	SSW	30.30			87/38	H-58 L-33
23	Clear	42	<1	10	NW	30.43			78/36	H-60 L-32
24	Clear	42	<1	18	SSE	30.42			94/40	H-57 L-32
25	Cldy	49	6	26	SSE	30.12	.66		90/46	H-56.5 L-48.4
26	Rain	51	<1	20	S	29.56	.01		98/57	H-59.3 L-41.2
27	Clear	47	<1	18	W	29.89	.14		95/45	H-57 L-41
28	Cldy	50	<1	19	W	29.79			98/50	H-64 L-49
29	PC	48	<1	13	W	29.78	.01		97/48	H-57 L-41
30	Clear	42	<1	13	SW	29.90	.07		85/38	H-50 L-38
31										
							2.14"			X-50.7 X-36.9

Appendix H

Grain Size Analysis Reports

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Hydraulic Conductivity Approximation
Orleans, MA

Summary of Equations:

Vukovic and Soro — n=0.255*(1+0.83^u) U=(d60/d10)

$$n = 0.255\left(1 + 0.83^{U}\right)$$

Sheperds

$$K_{sat} = b * (d_{50})^{c}$$

b and c are read from Sheperds Chart

Hazen — Ksat=c(d10)^2; c=1.0 to 1.5; d10 (mm)

$$K = \frac{g}{v} \times 6 \times 10^{-4}\left[1 + 10\left(n - 0.26\right)\right]d_{10}^{2}$$

Kozeny-Carman — Ksat=g/viscosity*8.3*0.0018[n^3/(1-n)^2]*d10^2

$$K = \frac{g}{v} \times 8.3 \times 10^{-3}\left[\frac{n^{3}}{(1-n)^{2}}\right]d_{10}^{2}$$

Slitcher — Ksat=g/viscosity*1*0.01*n^3.287*d10^2

$$K = \frac{g}{v} \times 1 \times 10^{2}\, n^{3.287}\, d_{10}^{2}$$

g	9.81 m/s^2
viscosity	1.004E-06 m^2/s

Summary of Results

Soil sample	Sample No./ Material	CTS Laboratory No.	Depth (ft)	D10 (mm)	D50 (mm)	D60 (mm)	U(d60/d10)	n (porosity)	Classification	Fines(%)	Kozeny-Carman Ksat (ft/day) *Most widely accepted, fine sand with d10 between 0.1 to 3mm*	Sheperds Ksat (ft/day) *Wide range of application (see Sheperds Equation chart)*	Hazen Ksat (ft/day) *Uniformly graded sand and fine sand with d10 between 0.1 to 3mm, and U<5*	Slitcher Ksat (ft/day) *Applicable for grain-size between 0.01mm and 5mm*	Sample Average (FT/day)
LH-2	1	18-S-163	30-40	0.1044	0.3433	0.3887	3.72	0.38	Poorly graded SAND with Silt	0.02	36.76	79.98	40.29	12.82	**42.46**
LH-5	1	18-S-164	80-96	0.1231	0.231	0.2592	2.11	0.43	Poorly graded SAND	0.03	82.67	41.60	67.25	25.61	**54.28**
LH-2	2	18-S-165	106	0.0133	0.0437	0.0511	3.84	0.38	SILT with SAND	0.44		2.67			**2.67**
LH-5	2	18-S-166	118	0.0066	0.0348	0.0467	7.1	0.32	SILT with SAND	0.06		1.83			**1.83**
LH-5	3	18-S-167	124-132	0.0974	0.1977	0.2159	2.22	0.42	Poorly graded SAND	0.96		32.18		15.61	**23.89**
LH-2	3	18-S-168	106-108		0.1004	0.113		0.51	Silty SAND	0.47		10.52			**10.52**
MW-2(235-245)	1	18-S-169	36		0.2097	0.2628		0.51	Silty SAND	0.58		35.46			**35.46**
MW-2(235-245)	2	18-S-170	66	0.1215	0.3175	0.357	2.94	0.40	Poorly graded SAND	0.11	61.93	70.31	59.46	20.52	**53.06**
MW-2(235-245)	3	18-S-171	101	0.007	0.0303	0.0347	4.98	0.36	SILT	0.14		1.46			**1.46**
MW-2(235-245)	4	18-S-172	165	0.0067	0.0952	0.1185	17.72	0.26	Silty SAND	0.43		9.64			**9.64**
MW-2(235-245)	5	18-S-173	186-196	0.1045	0.1932	0.2137	2.04	0.43	Poorly graded SAND with Silt	0.10	61.01	30.98	48.87	18.78	**39.91**
MW-2(235-245)	6	18-S-174	226	0.166	0.5023	0.572	3.45	0.39	Poorly graded SAND with Silt	0.02	99.94	149.87	104.88	34.28	**97.24**

Grain size outside the equation applicability range
Insufficient grain size data

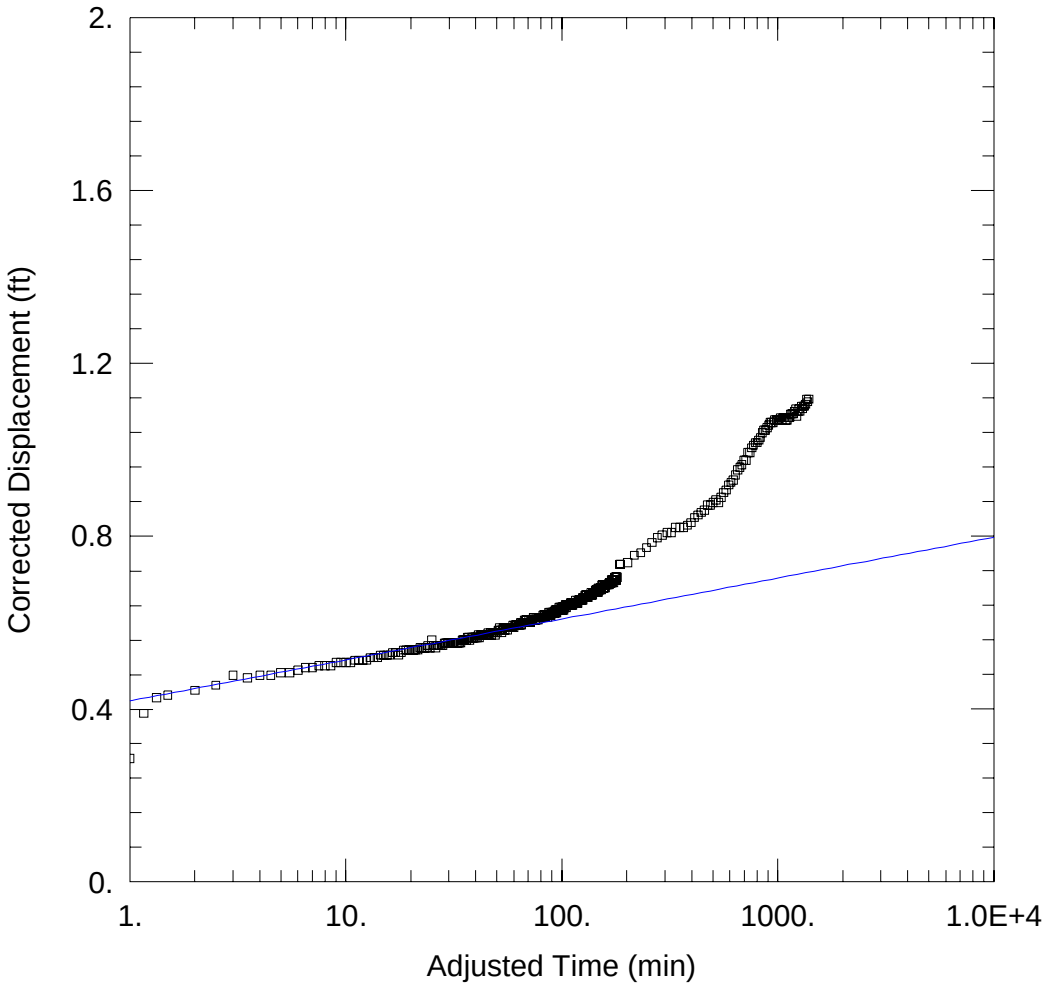
	Poorly graded SAND - Ksat (ft/day)	Poorly graded SAND with Silt - Ksat (ft/day)	SILT with SAND - Ksat (ft/day)	Silty SAND - Ksat (ft/day)	SILT - Ksat (ft/day)
	54.28	42.46	2.67	10.52	1.46
	23.89	39.91	1.83	35.46	
	53.06	97.24		9.64	
Average per soil class	**43.74**	**59.87**	**2.25**	**18.54**	**1.46**

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Appendix I

Pumping Test Analysis Reports

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WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-1S PPT\MW-16(110-120) pumping.aqt
Date: 09/14/17 Time: 14:24:13

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1S
Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.2948

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

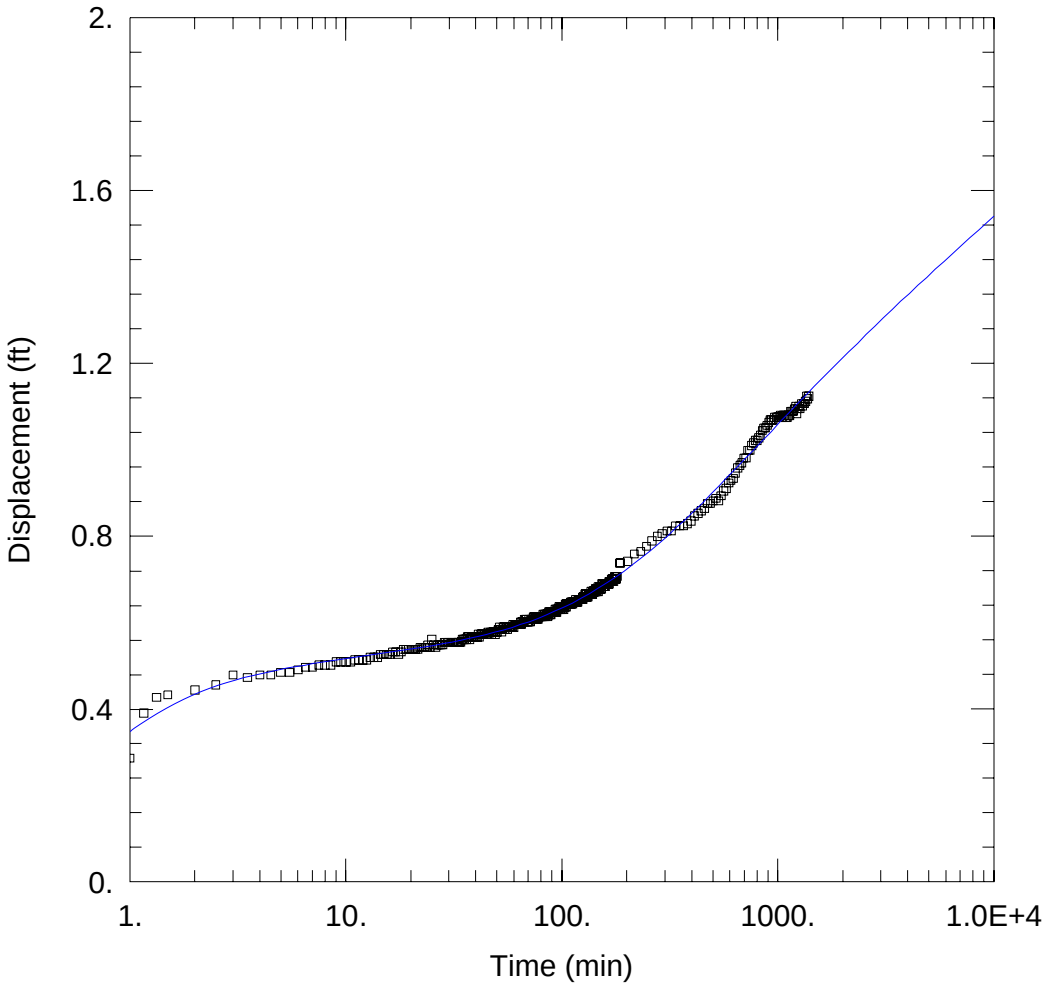
Observation Wells

Well Name	X (ft)	Y (ft)
MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 2.976E+4 ft^2/day S = 1.447E-6



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-1S PPT\MW-16(110-120) pumping.aqt
Date: 09/13/17 Time: 14:08:50

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1S
Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

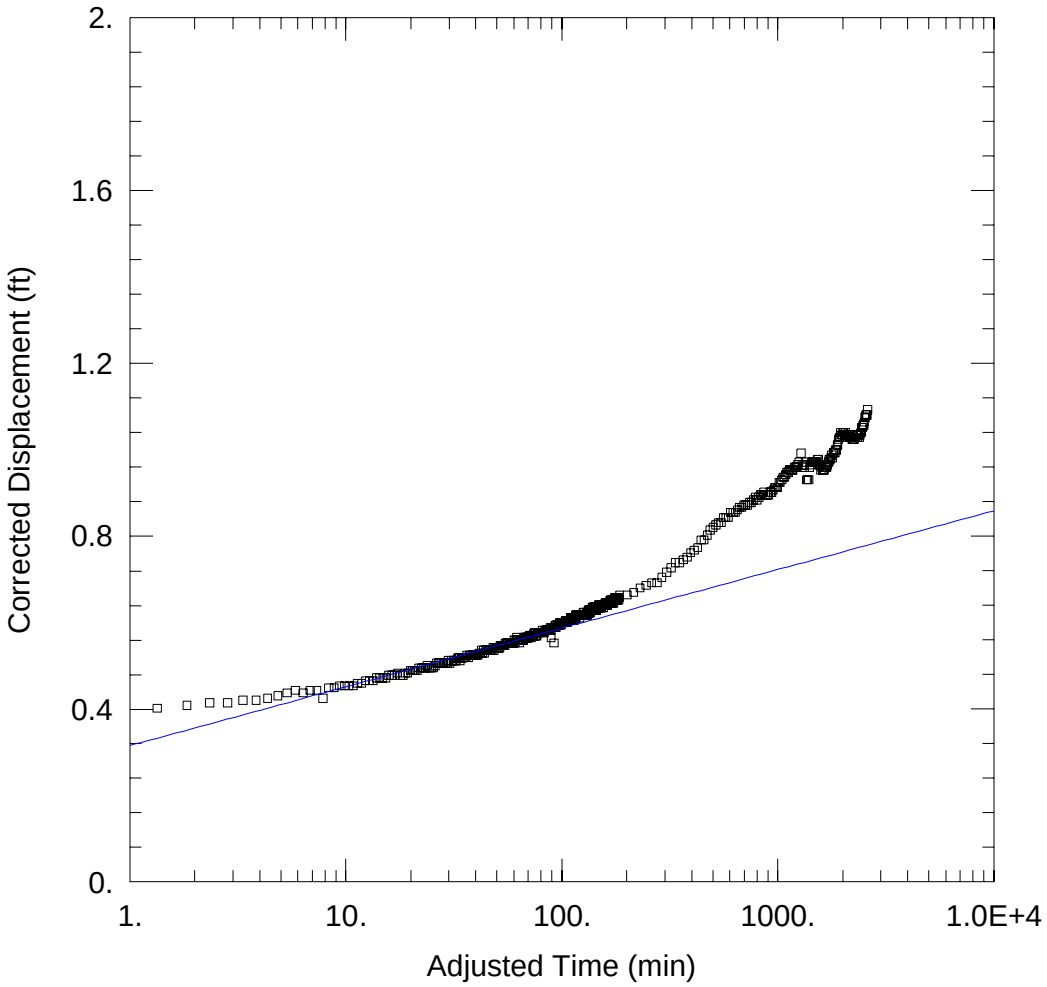
Observation Wells

Well Name	X (ft)	Y (ft)
MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 6461.7 ft^2/day
S = 0.003835
Sy = 0.146
ß = 0.03611



WELL TEST ANALYSIS

Data Set: C:\...\MW-16(110-120) recovery.aqt
Date: 09/14/17 Time: 14:29:47

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1S
Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.06865

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

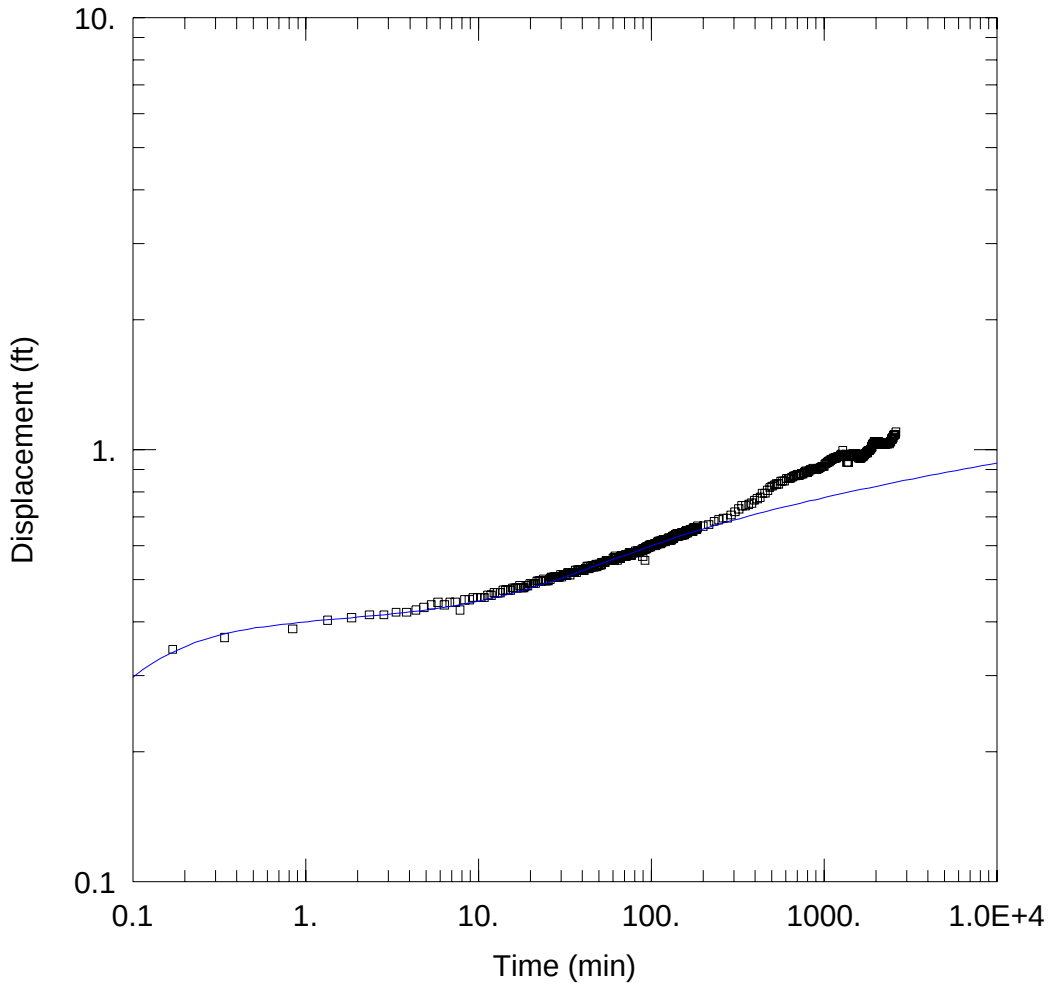
Observation Wells

Well Name	X (ft)	Y (ft)
MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 2.076E+4 ft^2/day S = 0.0001265



WELL TEST ANALYSIS

Data Set: C:\...\MW-16(110-120) recovery.aqt
Date: 09/13/17 Time: 16:56:13

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1S
Test Date: 8/1/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1S	0	0

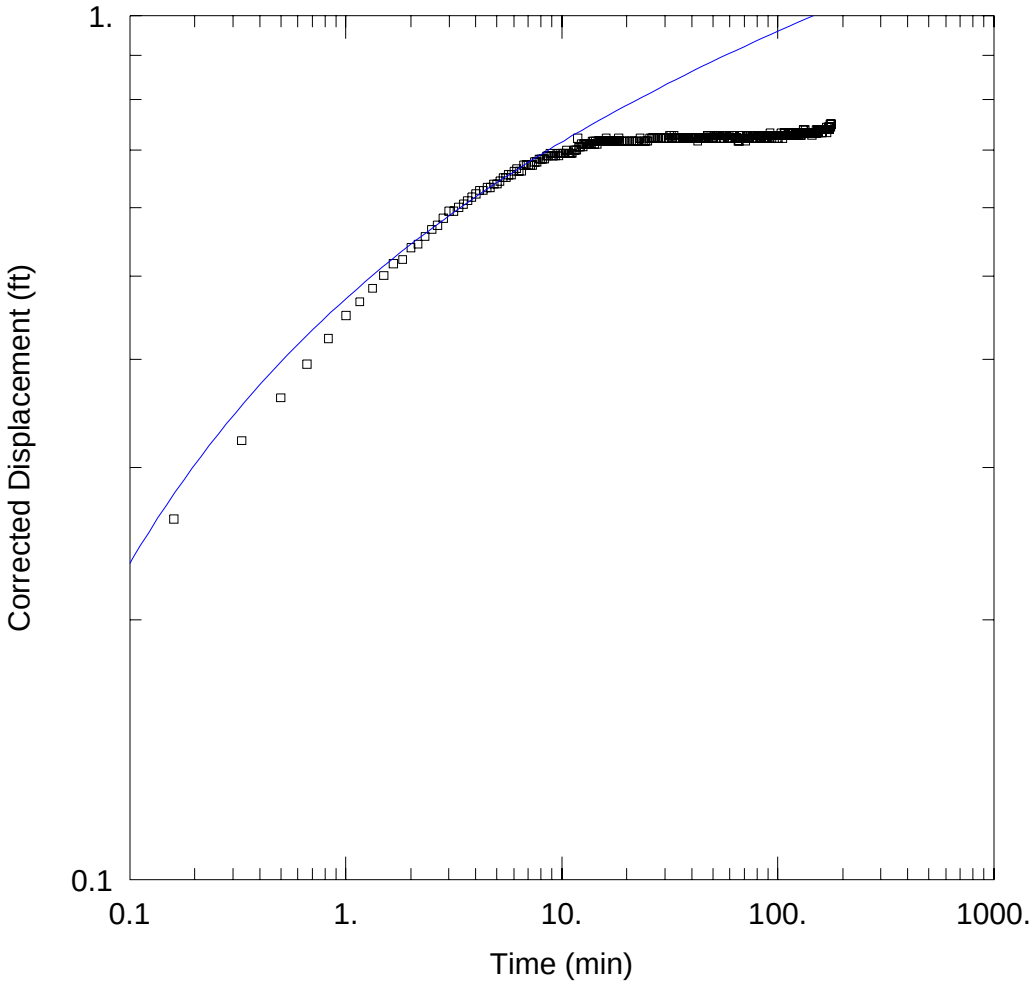
Observation Wells

Well Name	X (ft)	Y (ft)
MW-16(110-120)	35	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 1.814E+4 ft^2/day
S = 0.0004143
Sy = 0.01147
ß = 0.008409



WELL TEST ANALYSIS

Data Set:
Date: 09/14/17 Time: 16:53:15

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1D
Test Date: 8/3/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

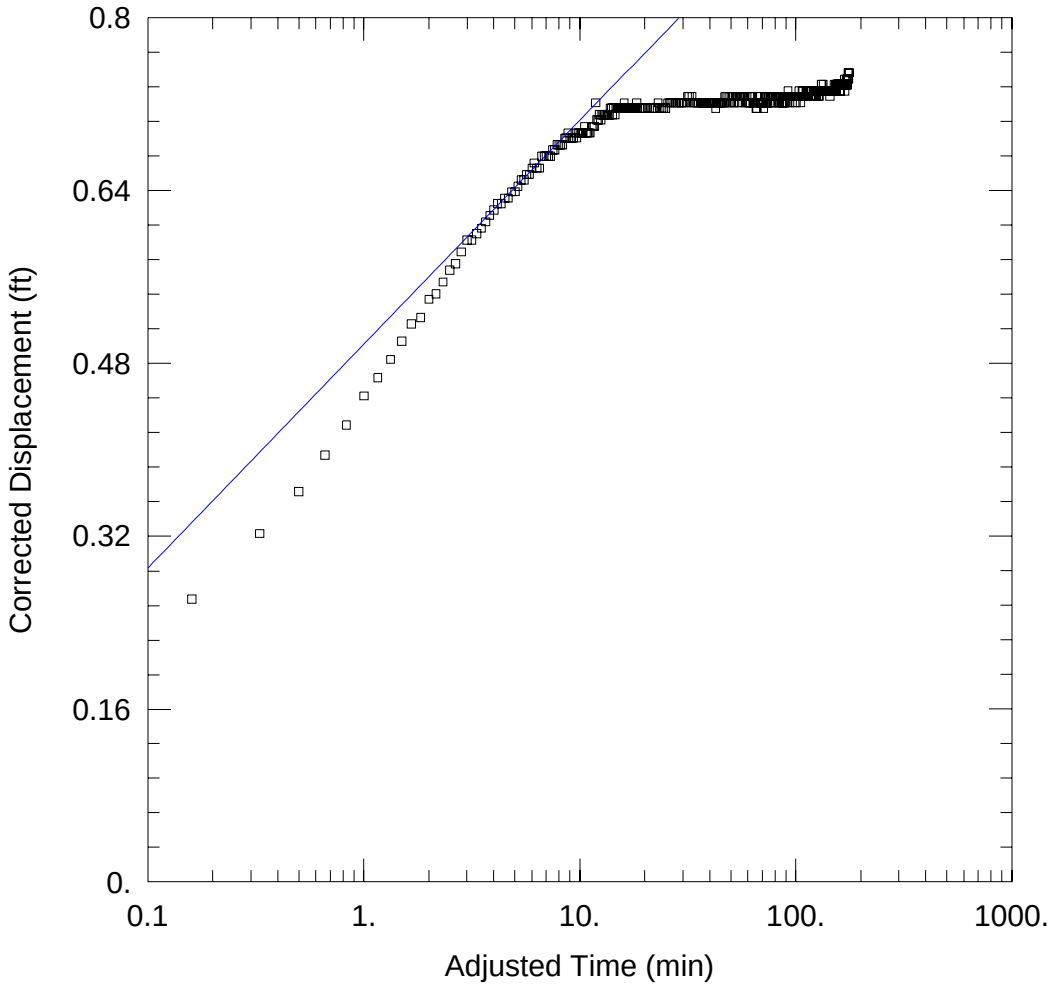
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 8.203 ft^2/min
S = 6.081E-5
Kz/Kr = 1.
b = 100. ft



WELL TEST ANALYSIS

Data Set:
Date: 09/14/17 Time: 16:54:46

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1D
Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

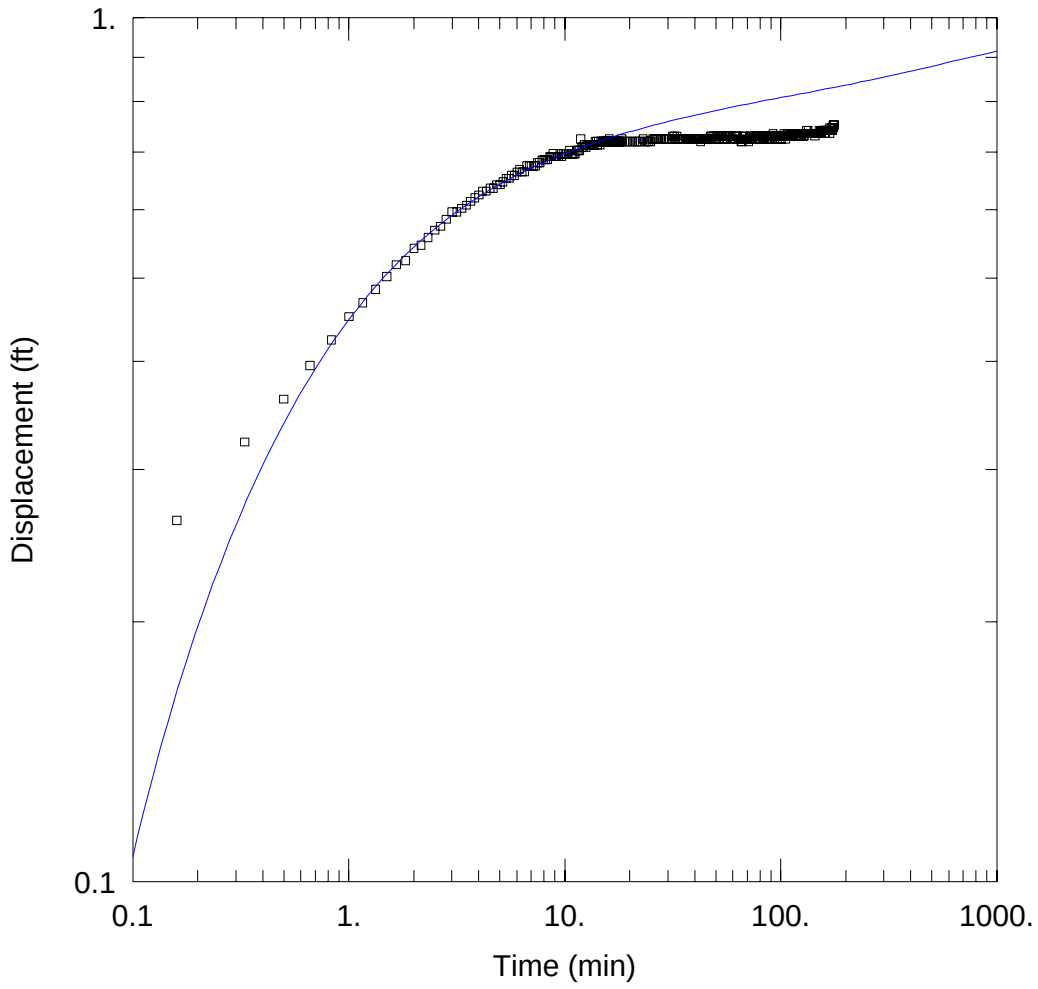
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 9.69 ft^2/min S = 2.244E-5



WELL TEST ANALYSIS

Data Set:
Date: 09/14/17 Time: 16:57:53

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1D
Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

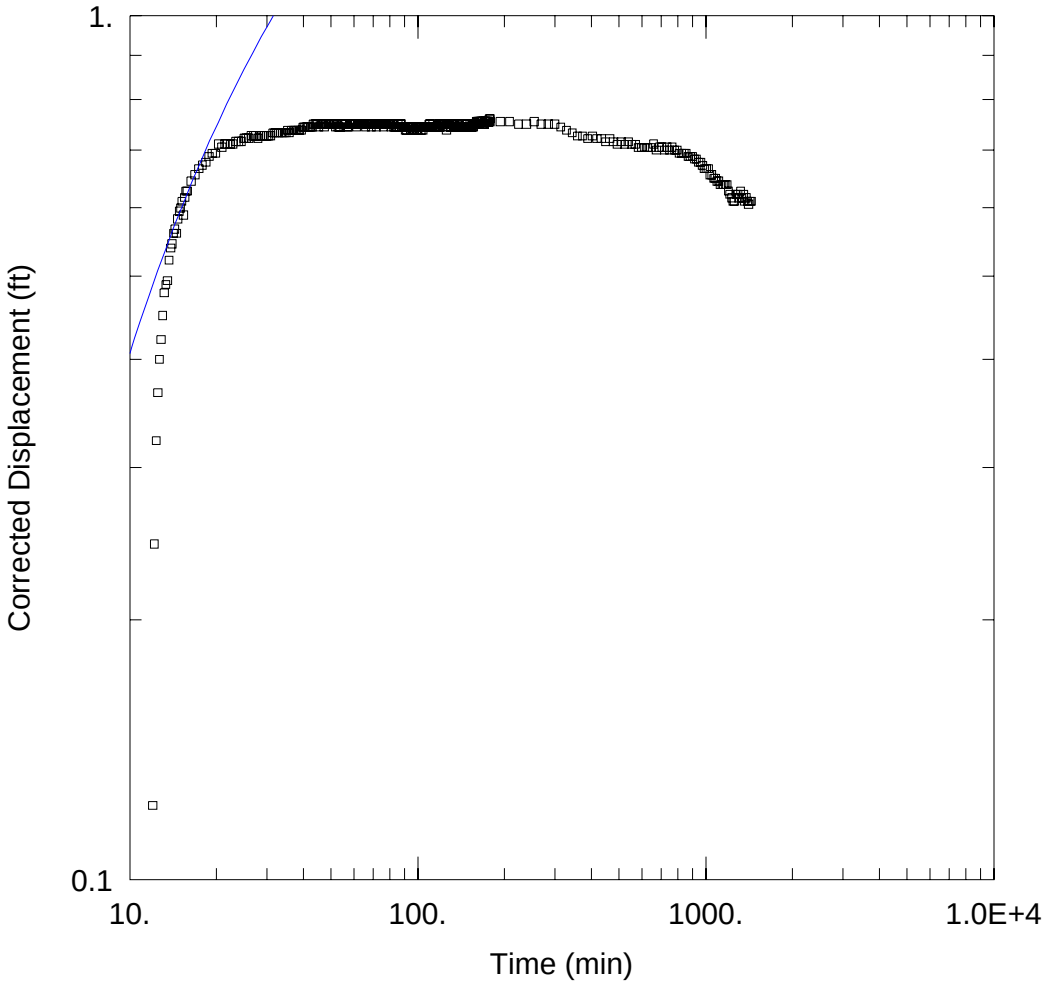
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 15.62 ft^2/min
S = 0.0007936
Sy = 0.001
ß = 0.001



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt
Date: 09/14/17 Time: 17:22:29

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1D
Test Date: 8/3/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

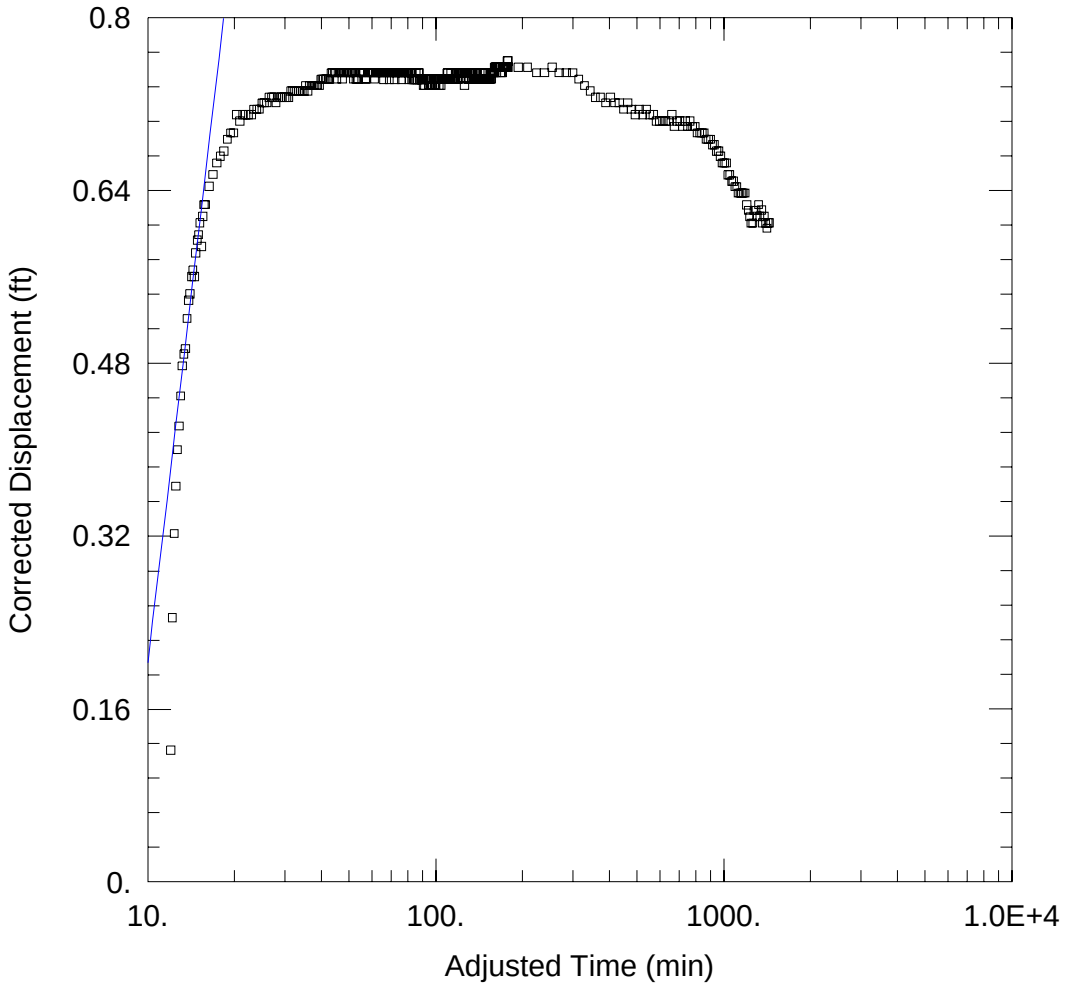
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 4.215 ft^2/min
S = 0.02088
Kz/Kr = 0.002601
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt
Date: 09/14/17 Time: 17:23:32

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-1D
Test Date: 8/3/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.002601

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-1D	0	0

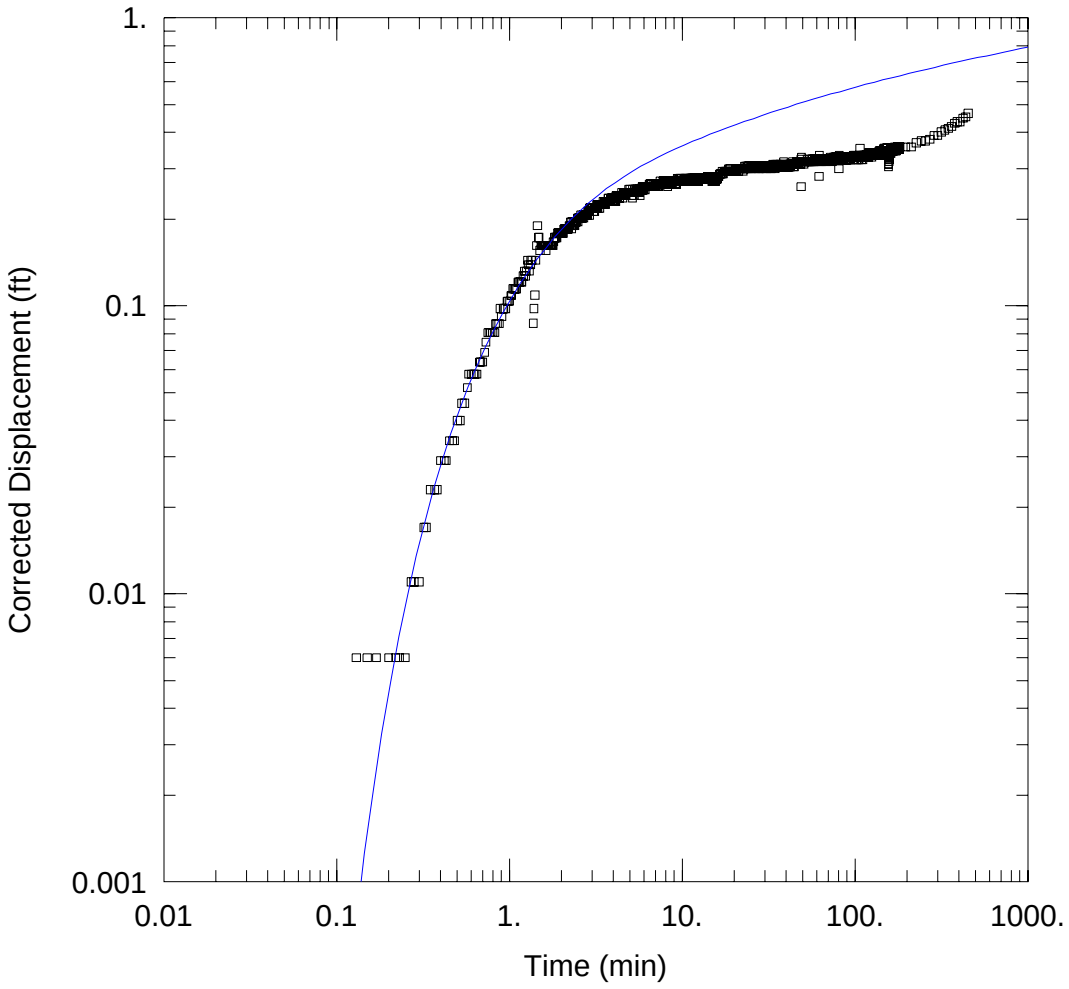
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	62	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 0.8863 ft^2/min S = 0.004215



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPT\MW-15S pumping.aqt
Date: 09/12/17 Time: 16:03:05

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0

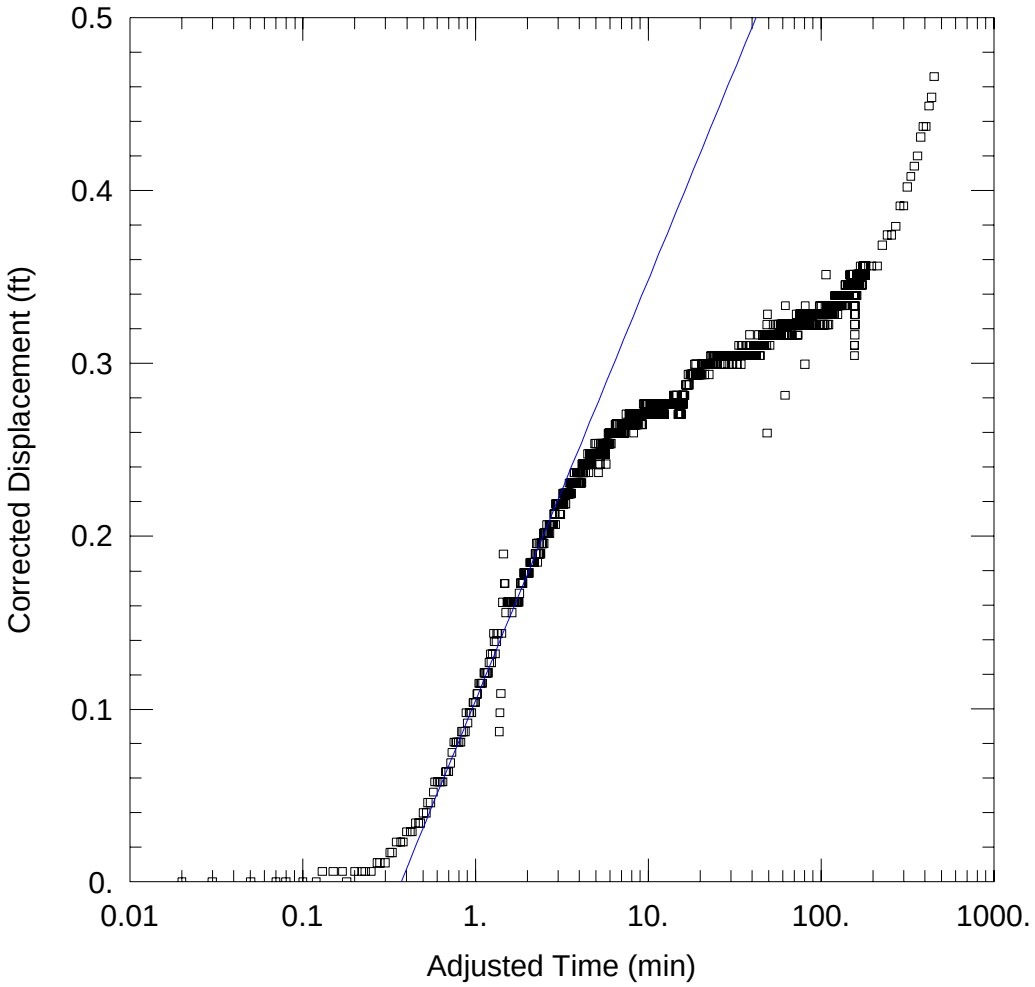
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-15S	106	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 9.229 ft^2/min
S = 0.001849
Kz/Kr = 0.06691
b = 103.5 ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPT\MW-15S pumping.aqt
Date: 09/12/17 Time: 16:02:26

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

AQUIFER DATA

Saturated Thickness: 103.5 ft Anisotropy Ratio (Kz/Kr): 0.06691

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0

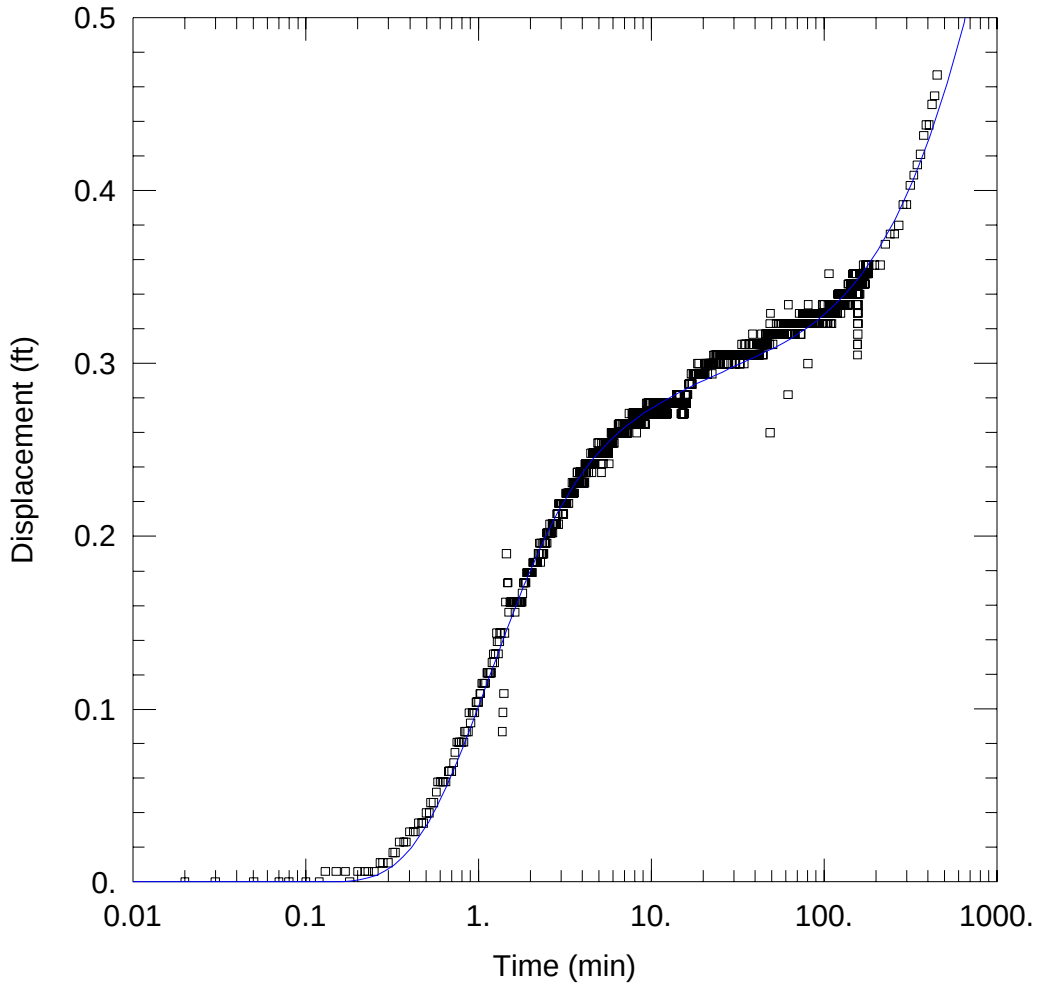
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15S	106	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 8.247 ft^2/min S = 0.0006118



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPT\MW-15S pumping.aqt
Date: 09/12/17 Time: 12:33:24

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

AQUIFER DATA

Saturated Thickness: 103.5 ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0

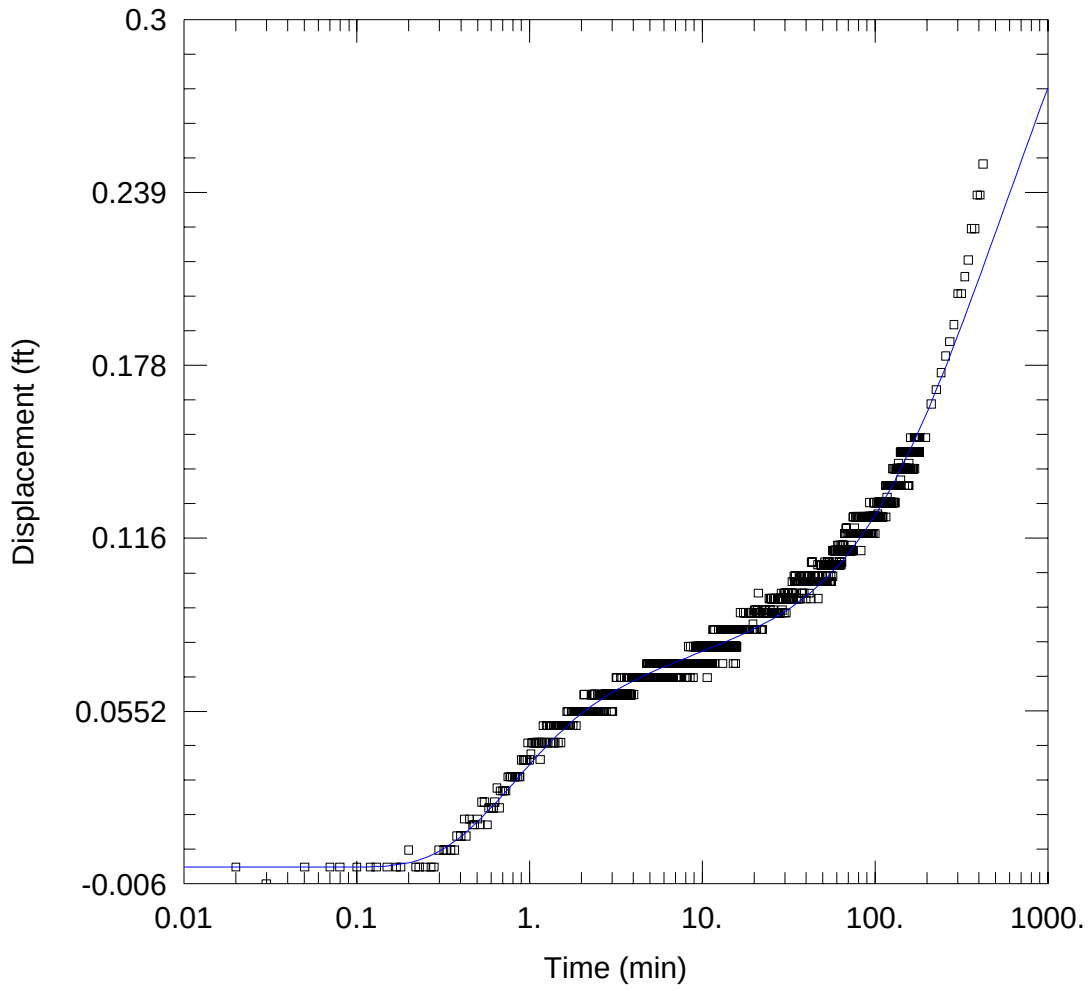
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15S	106	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 4.524 ft^2/min
S = 0.001443
Sy = 0.105
ß = 0.07014



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S PPT\PW-1S pumping.aqt
Date: 09/12/17 Time: 12:36:36

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

AQUIFER DATA

Saturated Thickness: 103.5 ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0

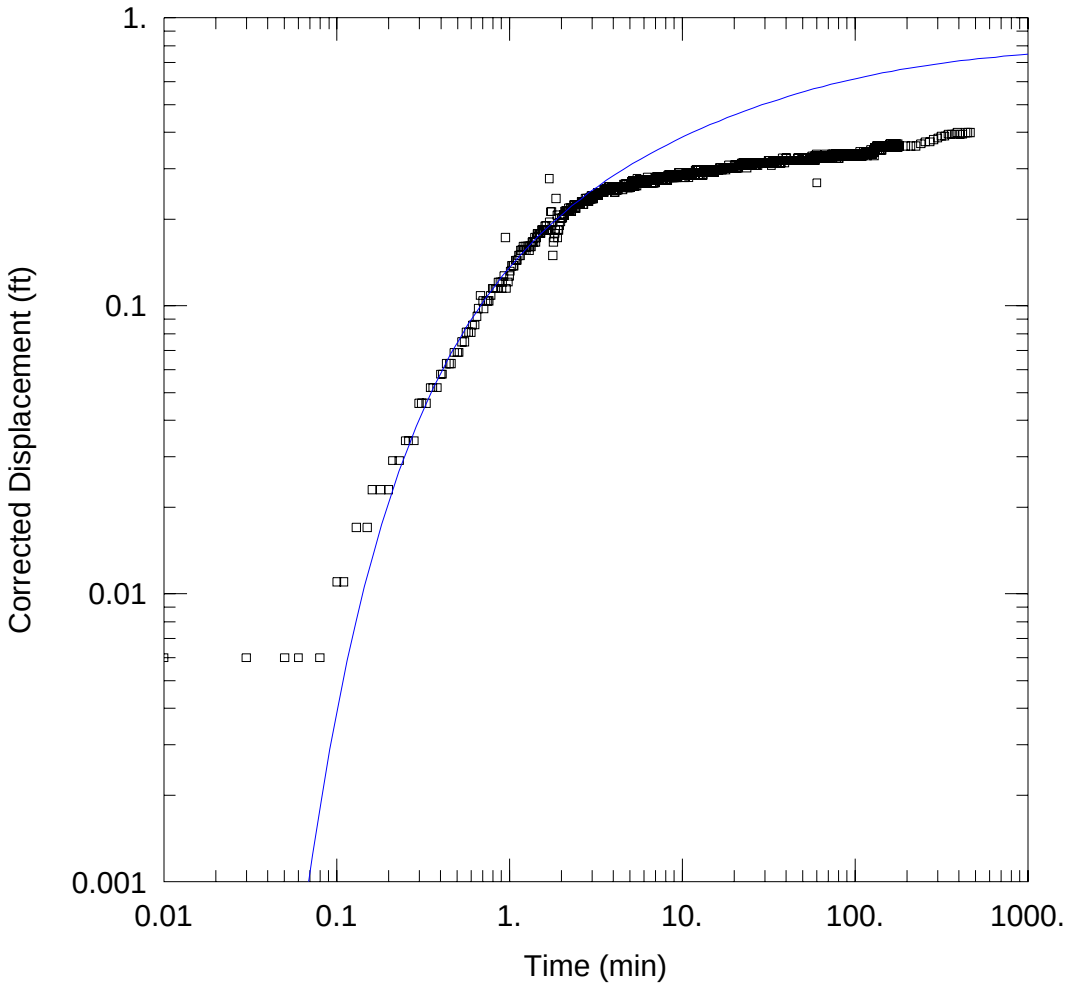
Observation Wells

Well Name	X (ft)	Y (ft)
PW-1S	160	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 13.98 ft^2/min
S = 0.001387
Sy = 0.03174
ß = 0.09565



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S Recovery\MW-15S Recovery.aqt
Date: 09/12/17 Time: 11:43:45

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0
MW-15S	106	0

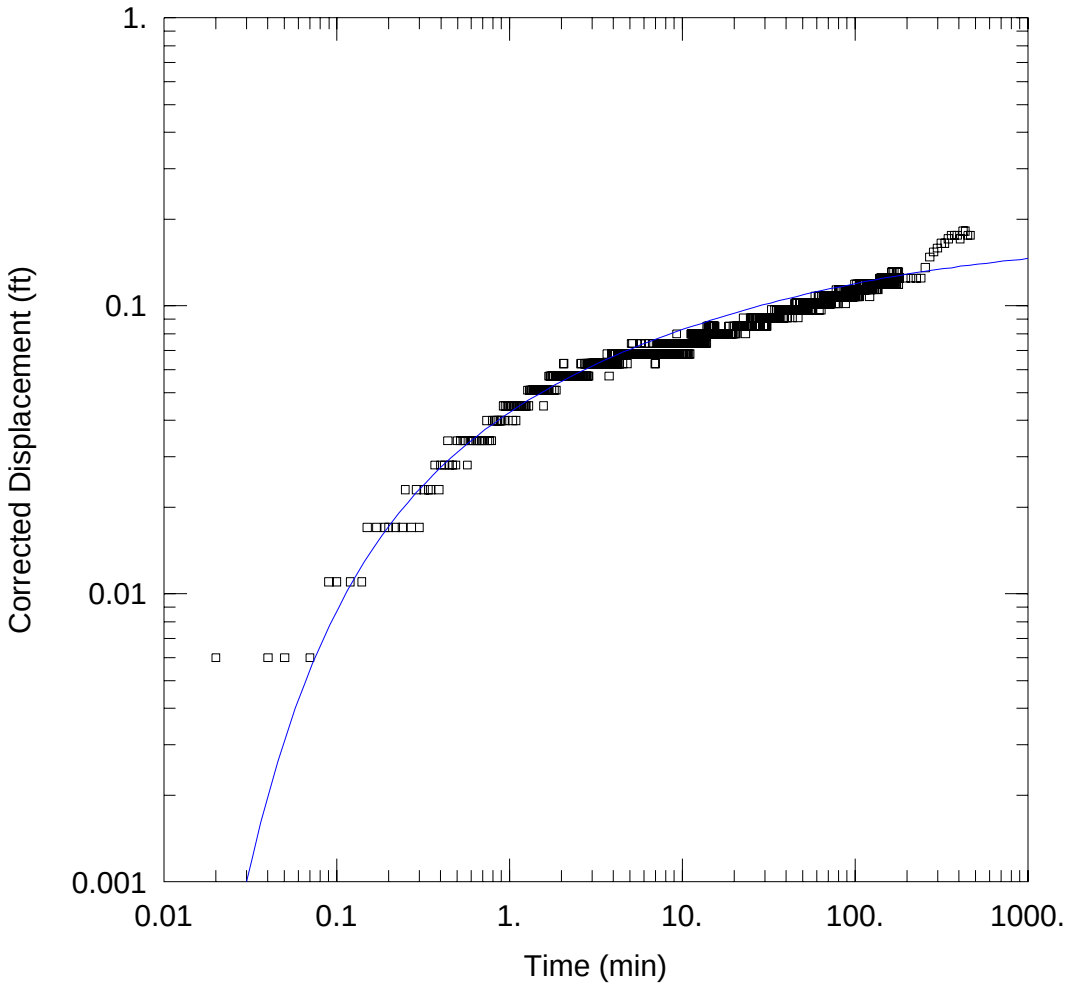
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15S	106	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 68.74 ft^2/min
S = 714.5
Kz/Kr = 1.
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2S Recovery\PW-1S Recovery.aqt
Date: 09/12/17 Time: 11:44:21

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-2S
Test Date: 8/17/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2S	0	0
PW-1S	160	0

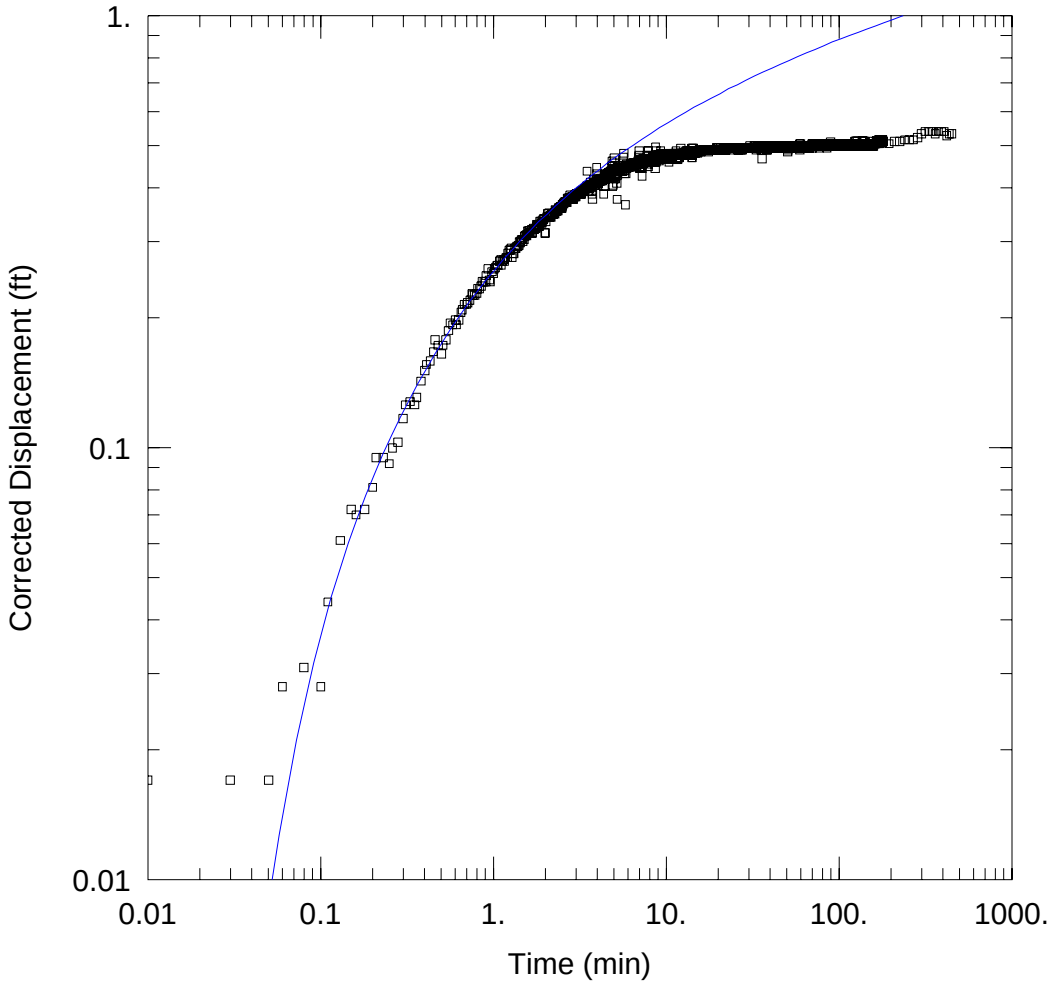
Observation Wells

Well Name	X (ft)	Y (ft)
PW-1S	160	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 156.3 ft^2/min
S = 404.4
Kz/Kr = 1.
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-15(140-150).aqt
Date: 09/12/17 Time: 14:41:06

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

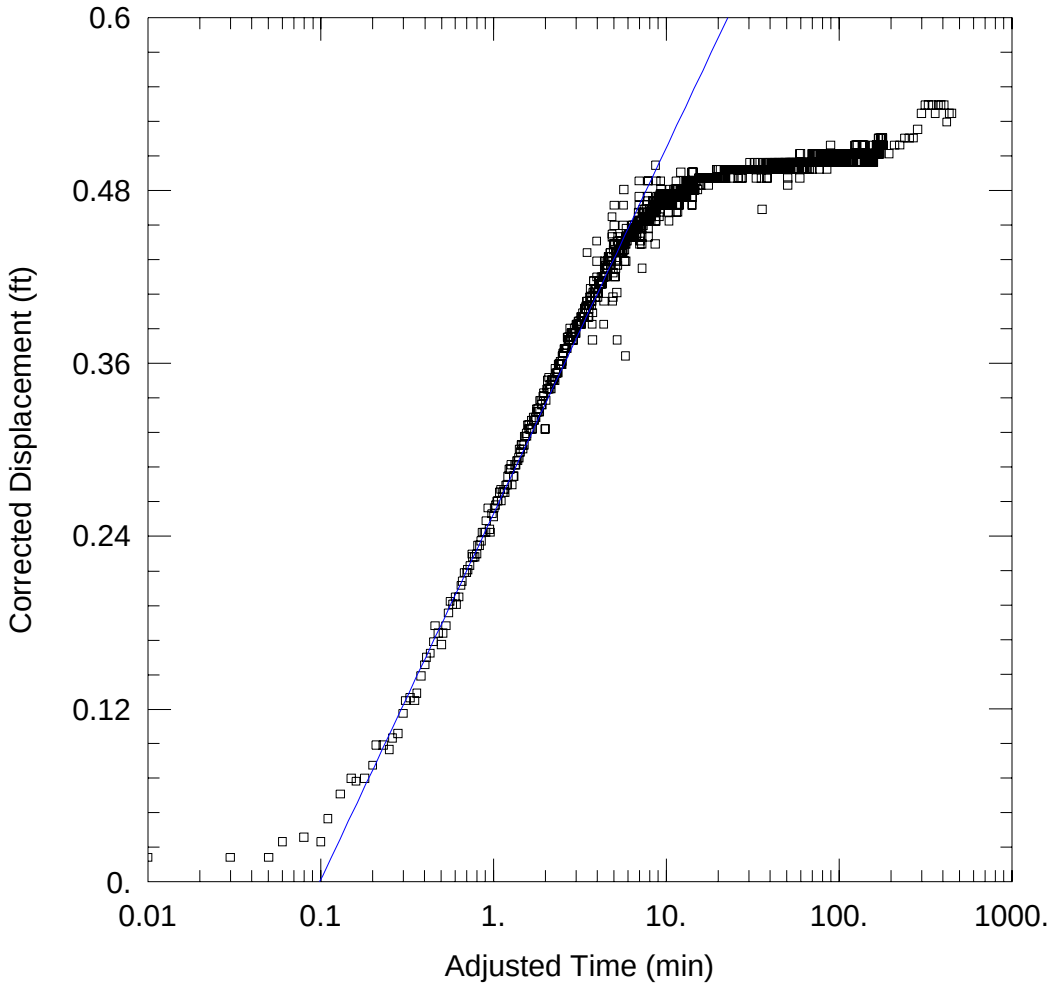
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 6.278 ft^2/min
S = 0.0002402
Kz/Kr = 0.1826
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-15(140-150).aqt
Date: 09/12/17 Time: 14:41:43

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.1826

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

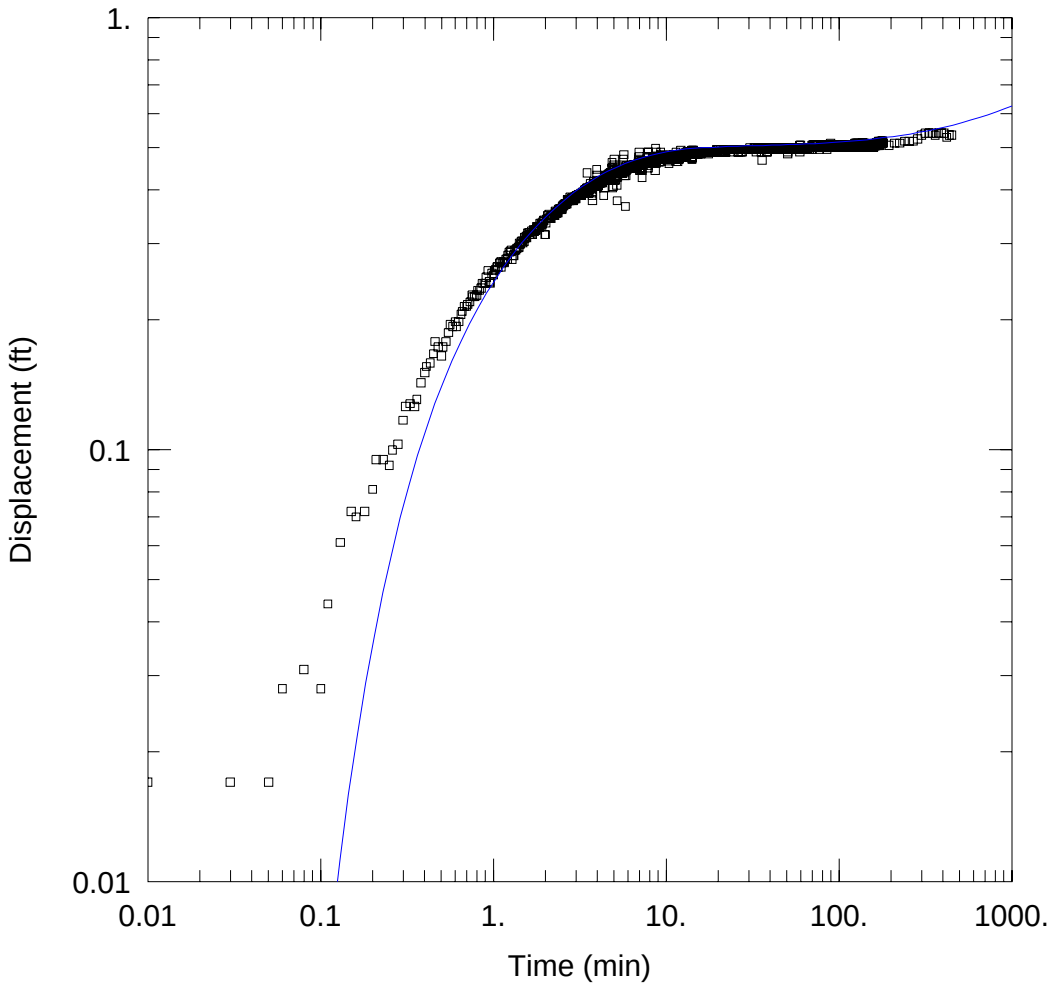
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 7.9 ft^2/min S = 0.0001504



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-15(140-150).aqt
Date: 09/12/17 Time: 14:42:32

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

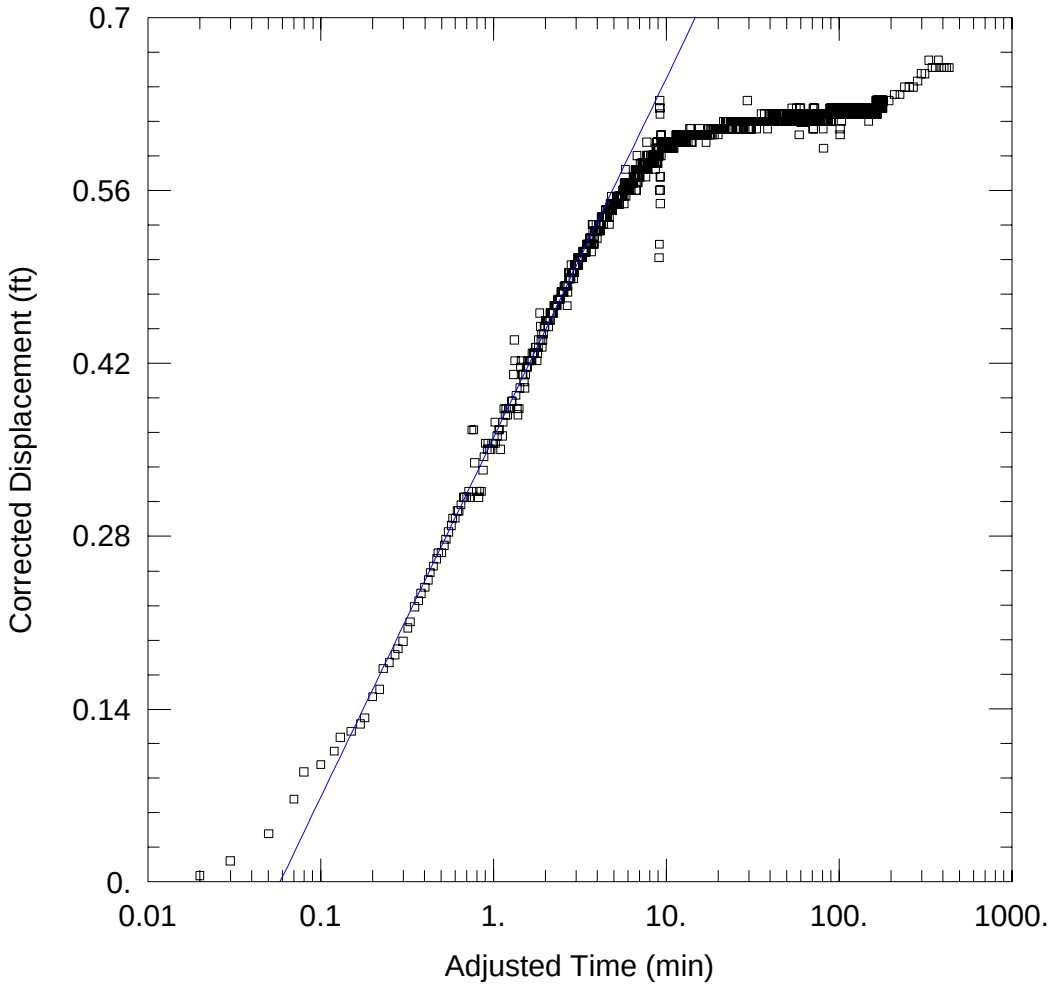
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 4.207 ft^2/min
S = 0.0004757
Sy = 0.1
ß = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-2(140-150).aqt
Date: 09/12/17 Time: 14:32:36

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.1826

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

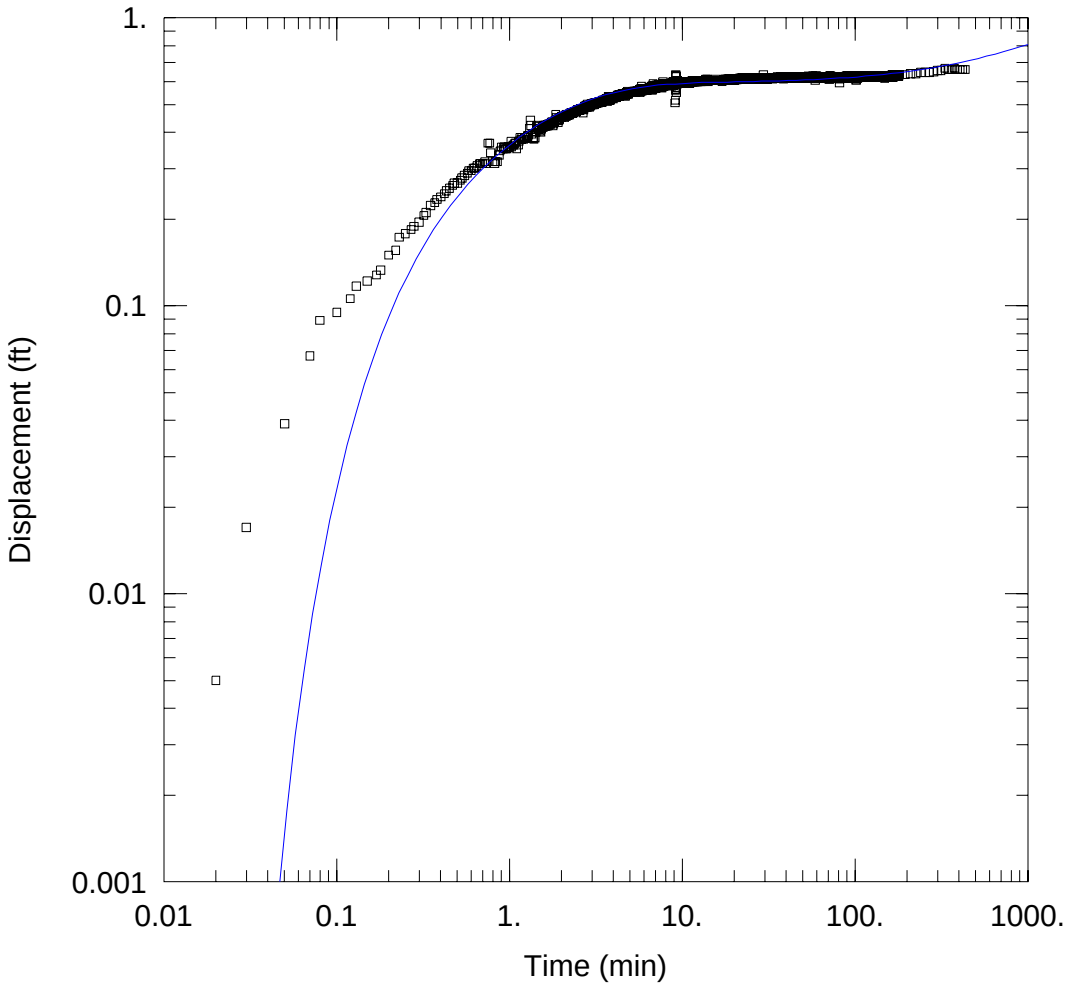
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 6.895 ft^2/min S = 0.0001648



WELL TEST ANALYSIS

Data Set:
Date: 09/12/17 Time: 14:31:36

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

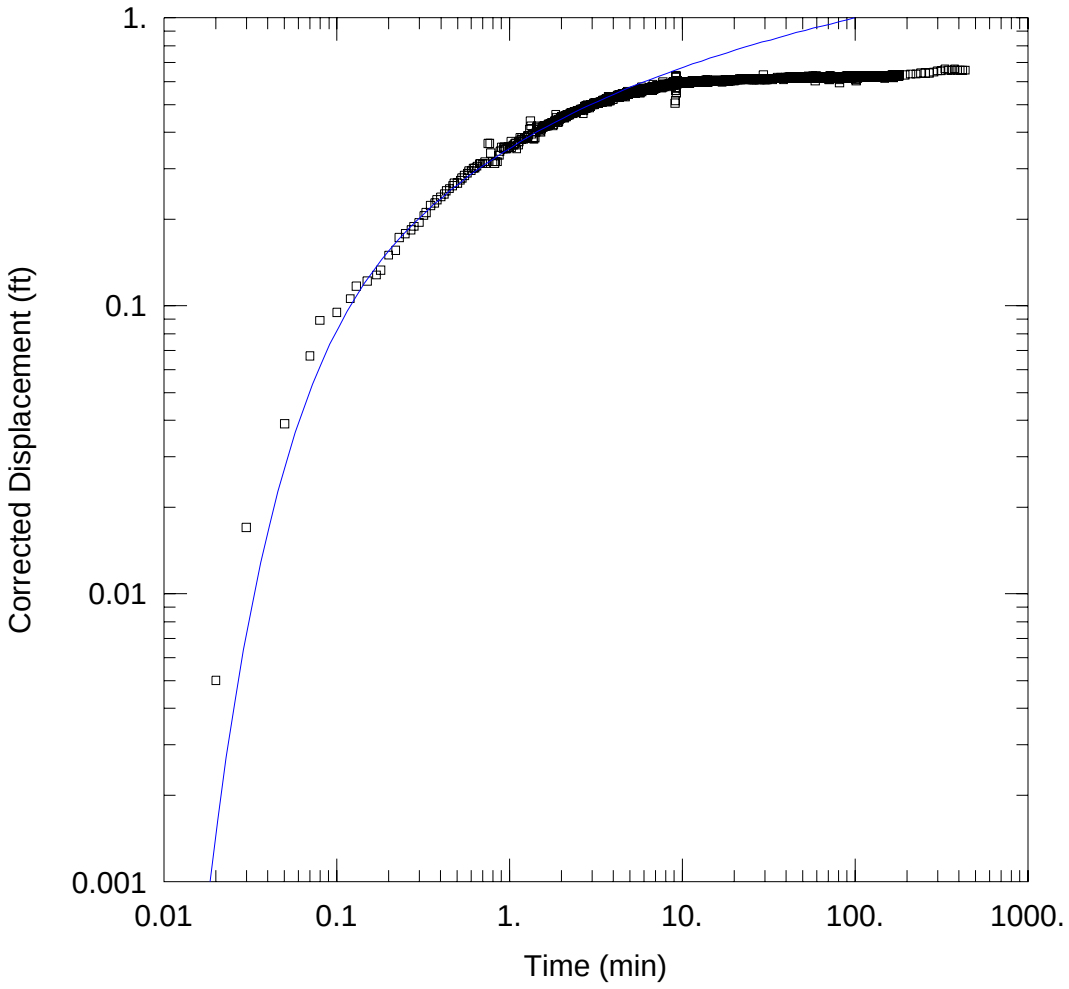
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 3.774 ft^2/min
S = 0.0005887
Sy = 0.1
ß = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\MW-2(140-150).aqt
Date: 09/12/17 Time: 14:33:22

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

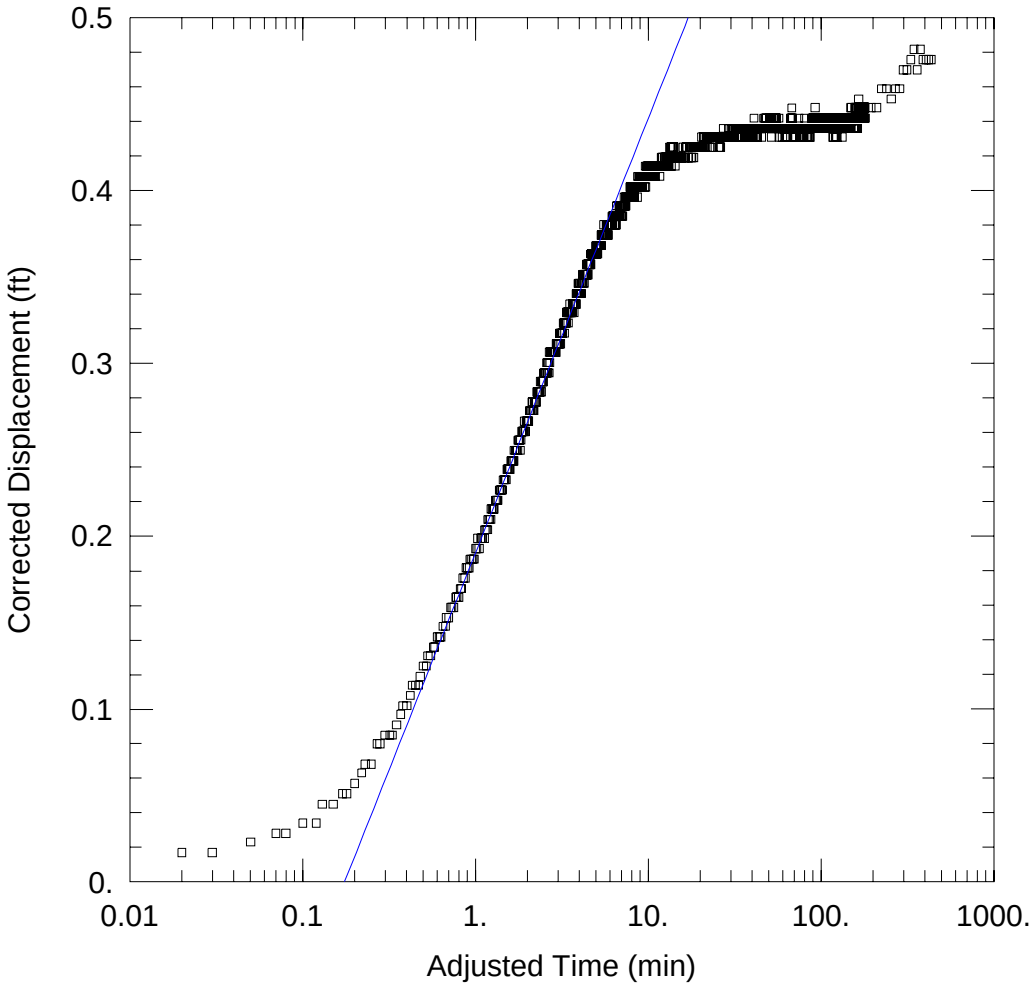
Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 6.092 ft^2/min
S = 0.0003581
Kz/Kr = 0.1826
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt
Date: 09/12/17 Time: 14:57:13

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.05251

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

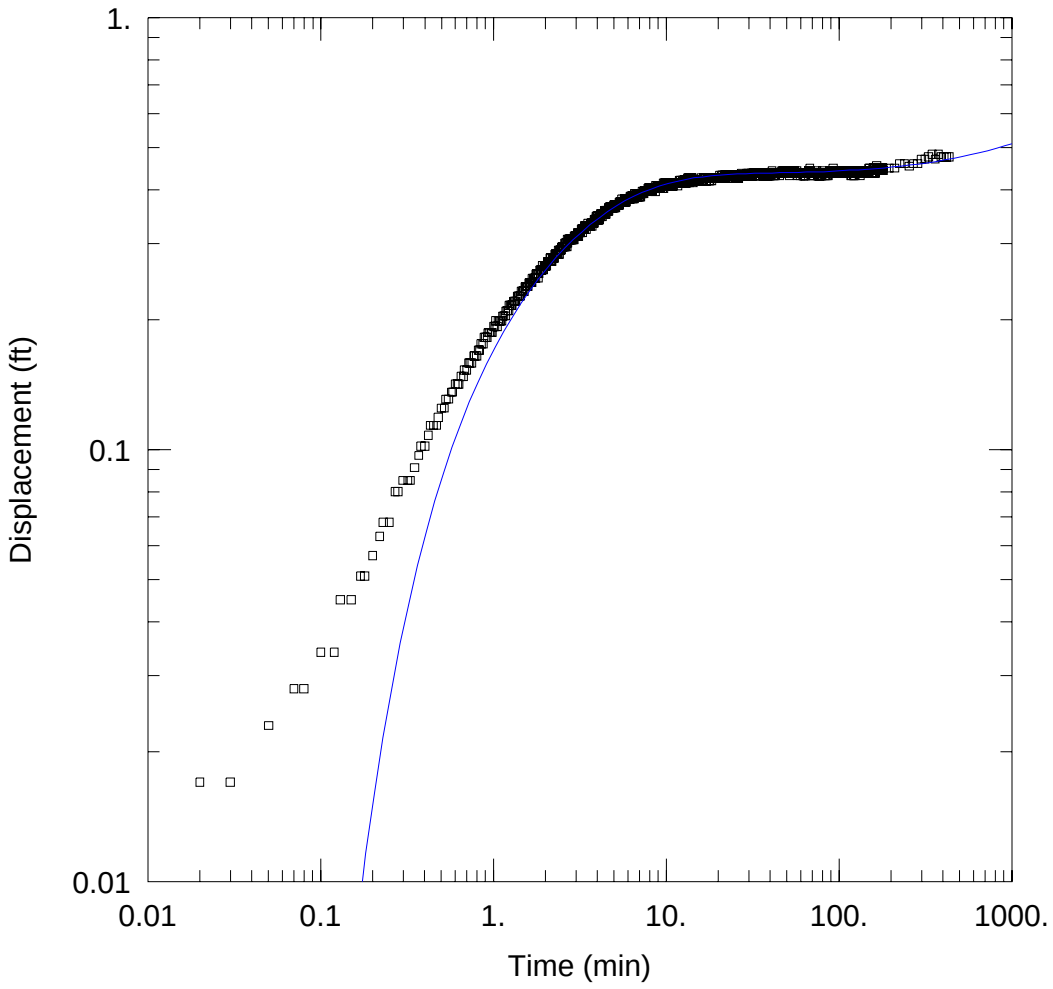
Observation Wells

Well Name	X (ft)	Y (ft)
PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 7.989 ft^2/min S = 0.0001647



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt
Date: 09/12/17 Time: 14:56:15

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

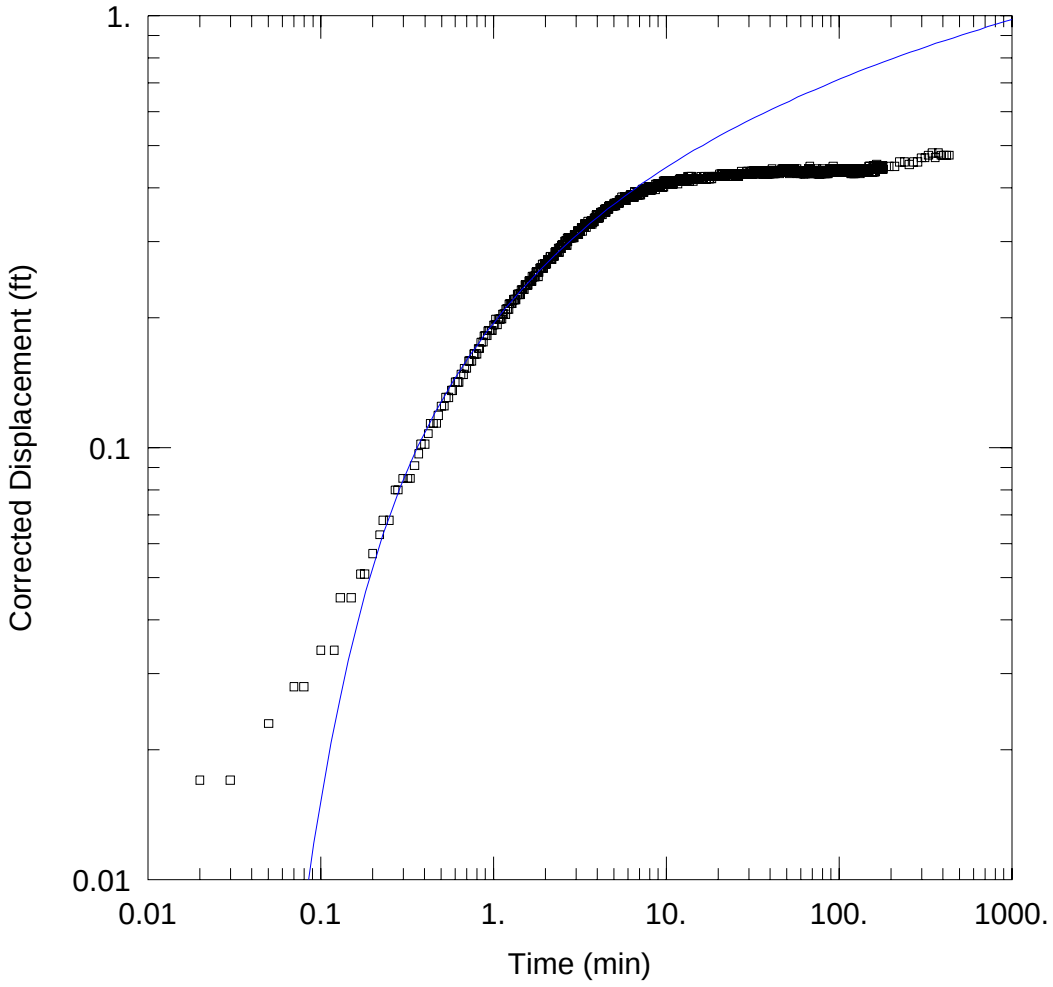
Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 4.962 ft^2/min
S = 0.0004494
Sy = 0.1
ß = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D PPT\PW-1D.aqt
Date: 09/12/17 Time: 14:57:49

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

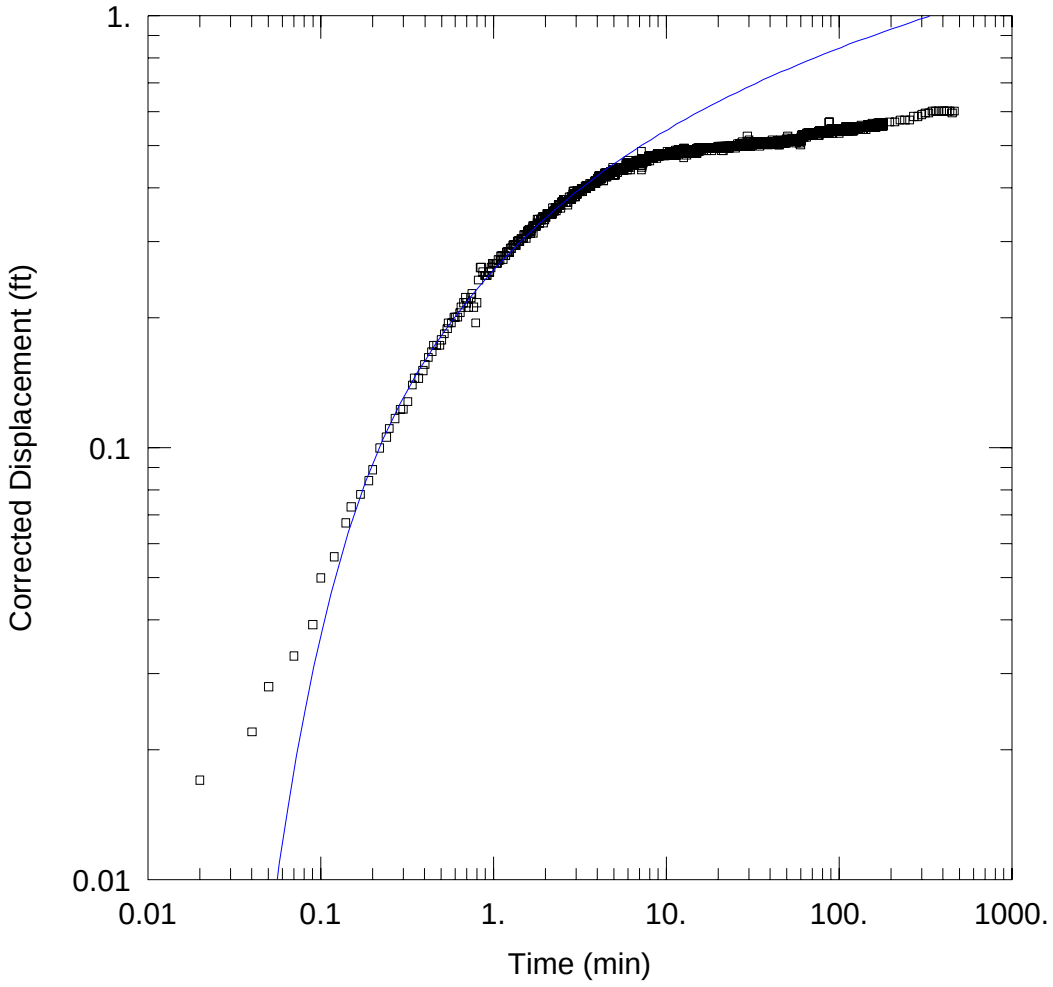
Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 7.468 ft^2/min
S = 0.0002859
Kz/Kr = 0.05251
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15(140-150) recovery.aqt
Date: 09/12/17 Time: 15:27:03

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

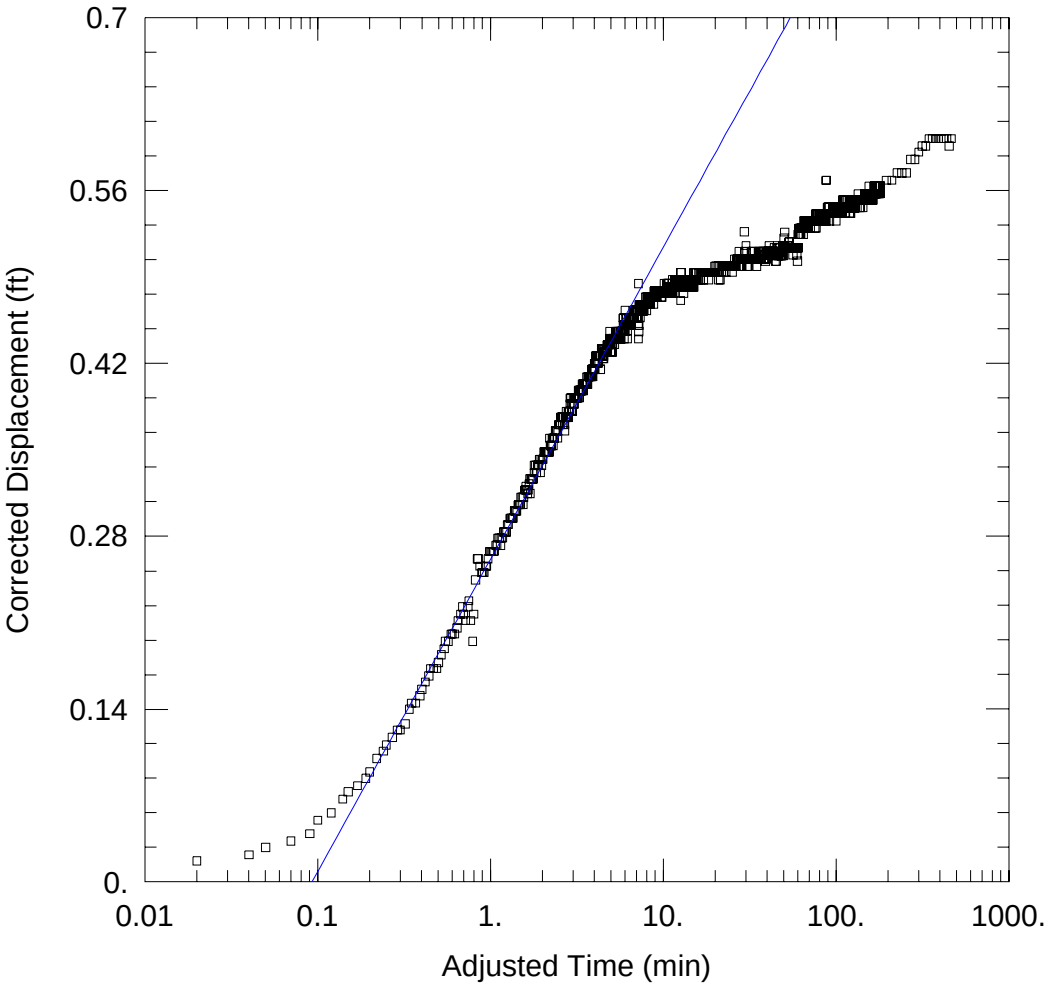
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 6.698 ft^2/min
S = 0.000291
Kz/Kr = 0.08573
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15(140-150) recovery.aqt
Date: 09/12/17 Time: 15:27:56

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.08573

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

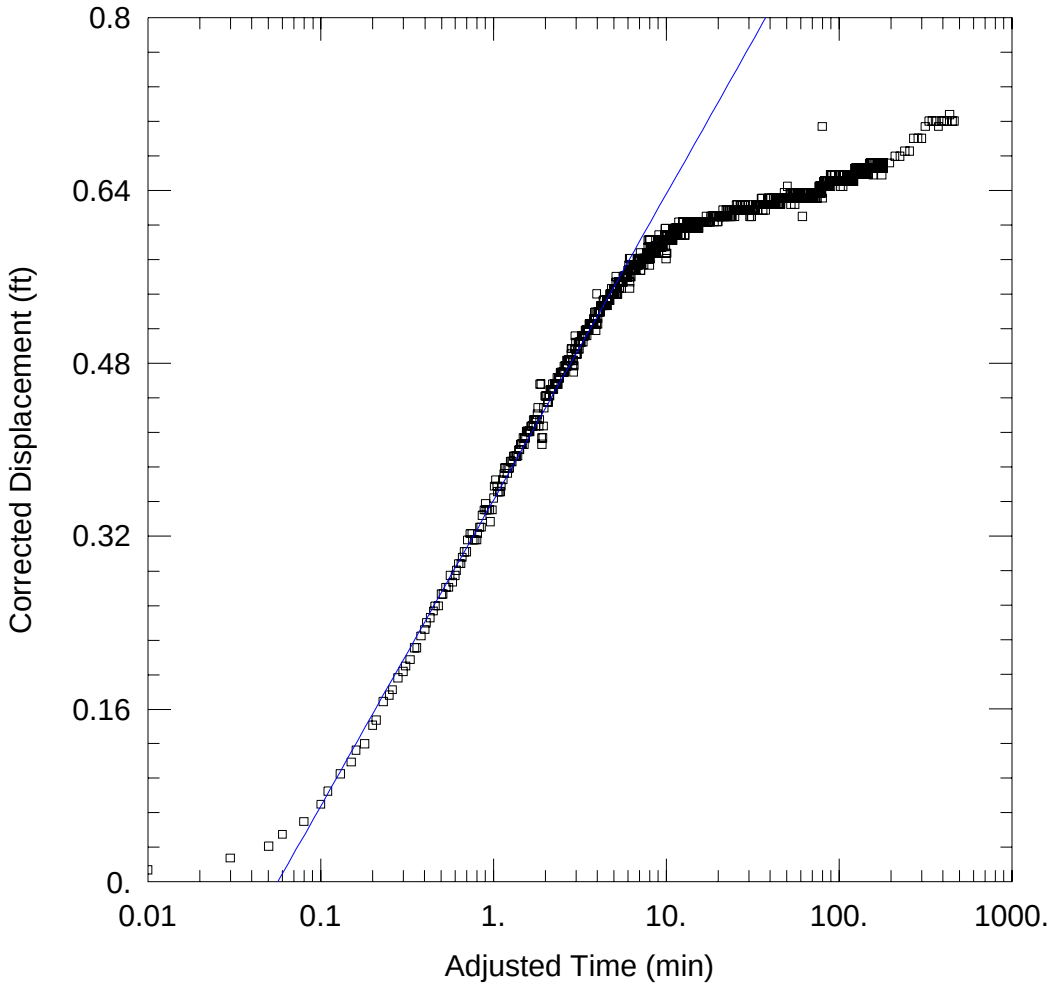
Observation Wells

Well Name	X (ft)	Y (ft)
MW-15(140-150)	108	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 7.94 ft^2/min S = 0.0001418



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt
Date: 09/12/17 Time: 15:13:01

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.1826

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

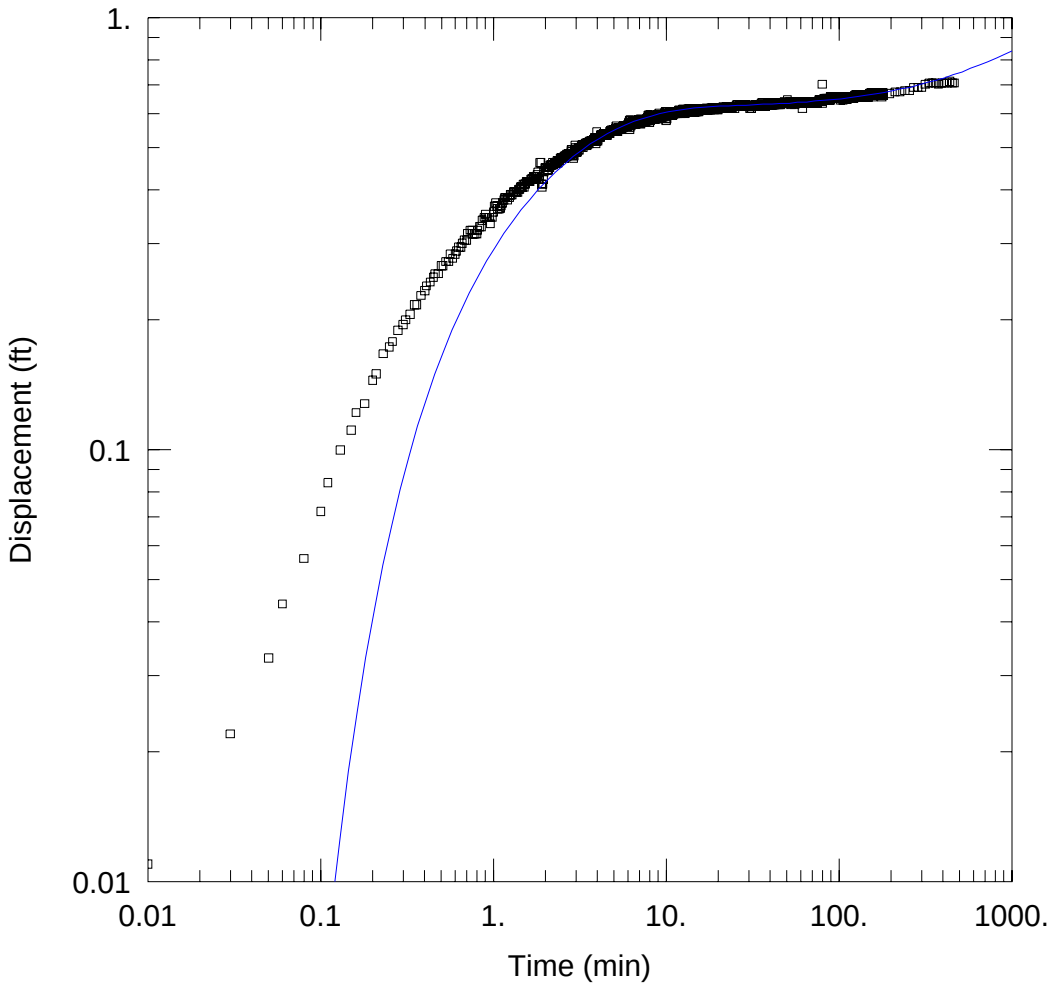
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 7.089 ft^2/min S = 0.0001645



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt
Date: 09/12/17 Time: 15:20:27

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

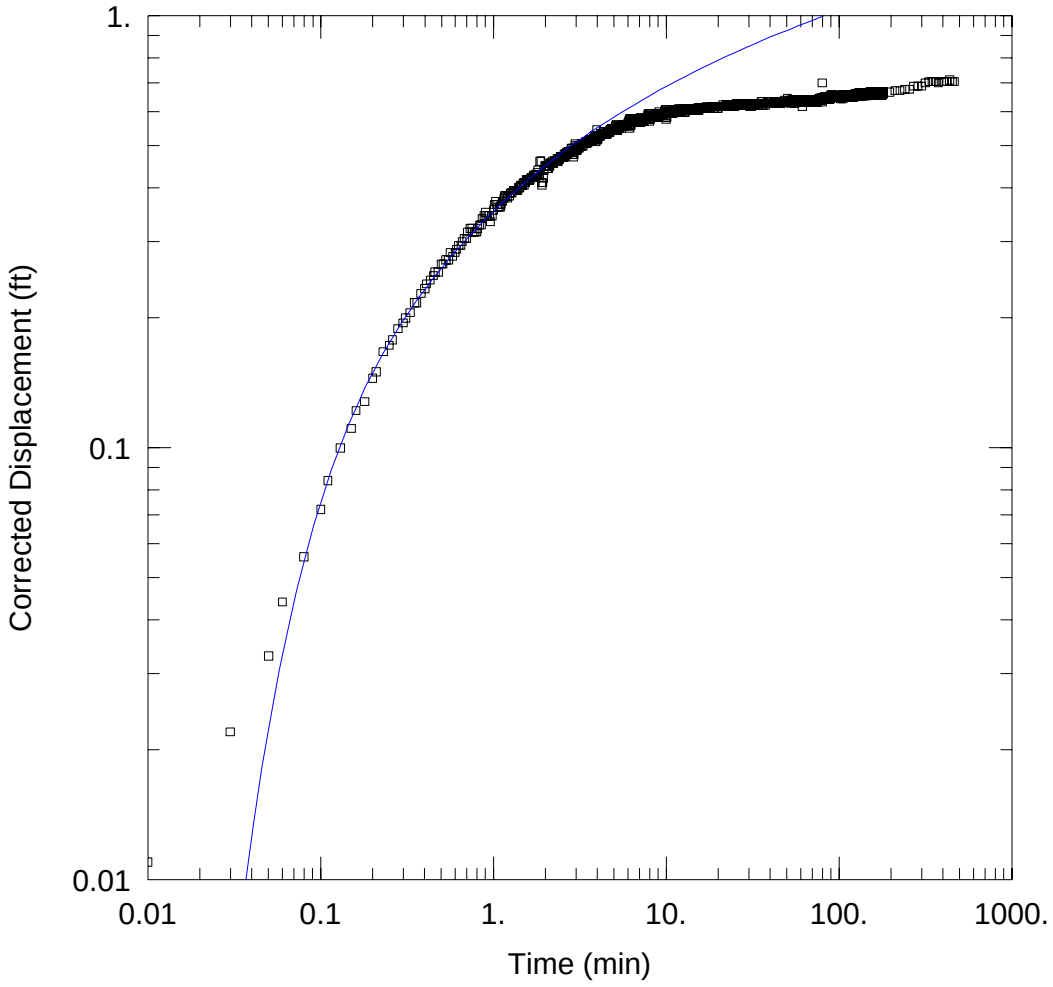
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 3.609 ft^2/min
S = 0.0009061
Sy = 0.1
ß = 0.1



WELL TEST ANALYSIS

Data Set: C:\...\MW-2(140-150) recovery.aqt
Date: 09/12/17 Time: 15:12:33

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

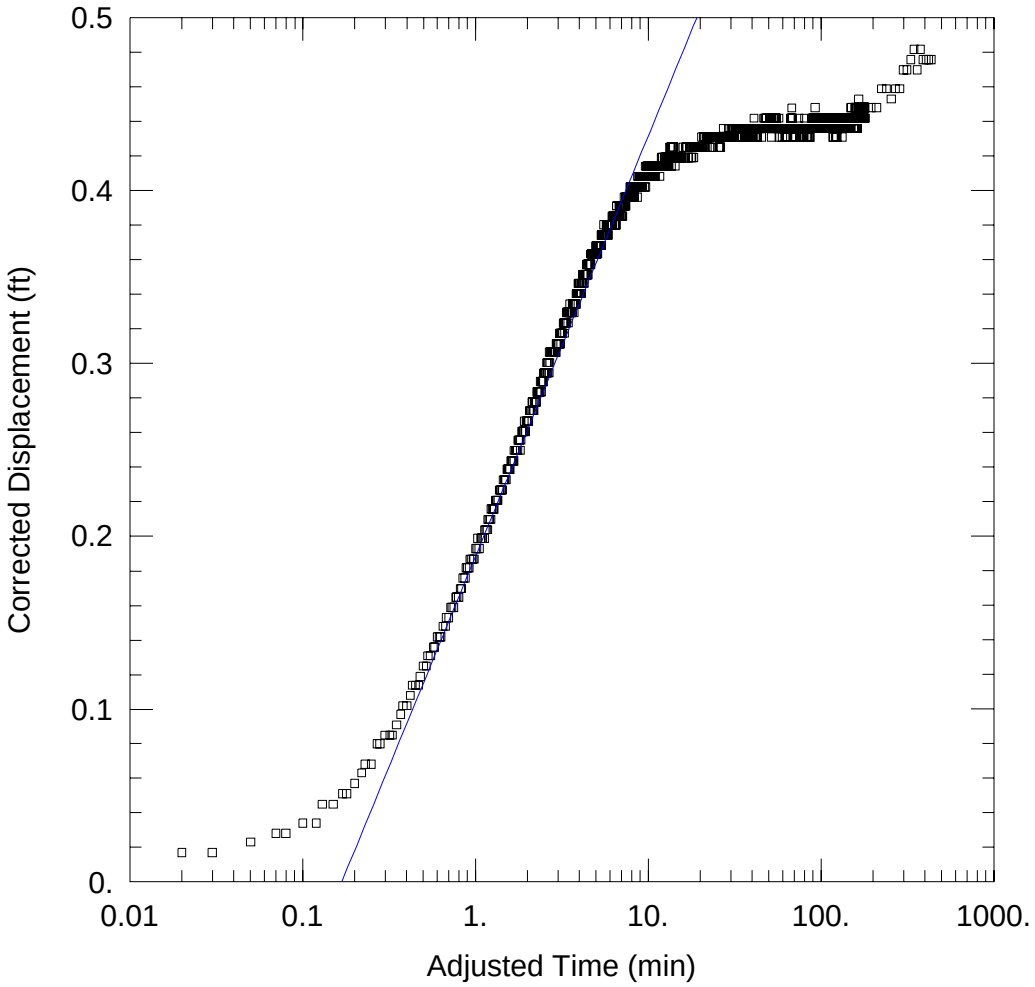
Observation Wells

Well Name	X (ft)	Y (ft)
MW-2(140-150)	74	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 5.824 ft^2/min
S = 0.0003832
Kz/Kr = 0.1826
b = 100. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt
Date: 09/12/17 Time: 15:34:12

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 0.05251

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

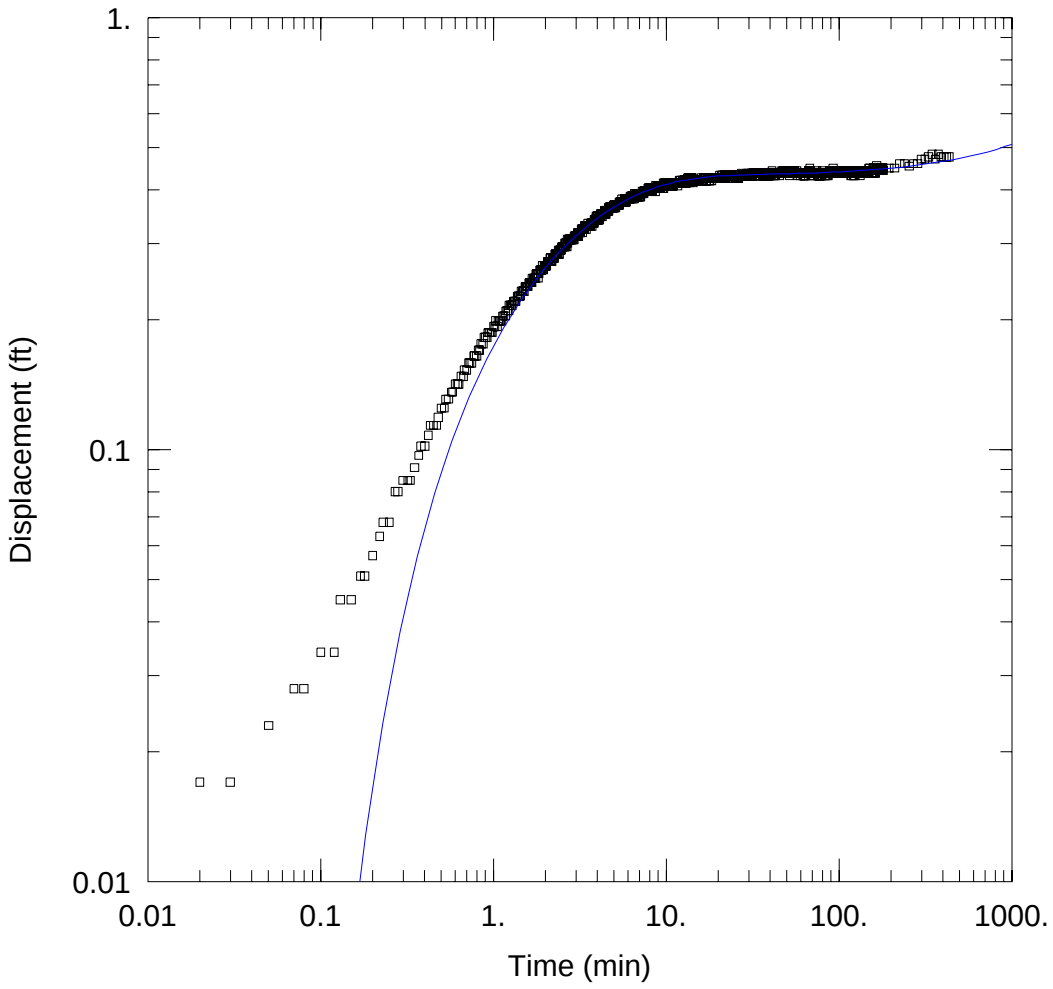
Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 8.253 ft^2/min S = 0.0001639



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt
Date: 09/12/17 Time: 15:34:43

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

AQUIFER DATA

Saturated Thickness: 100. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

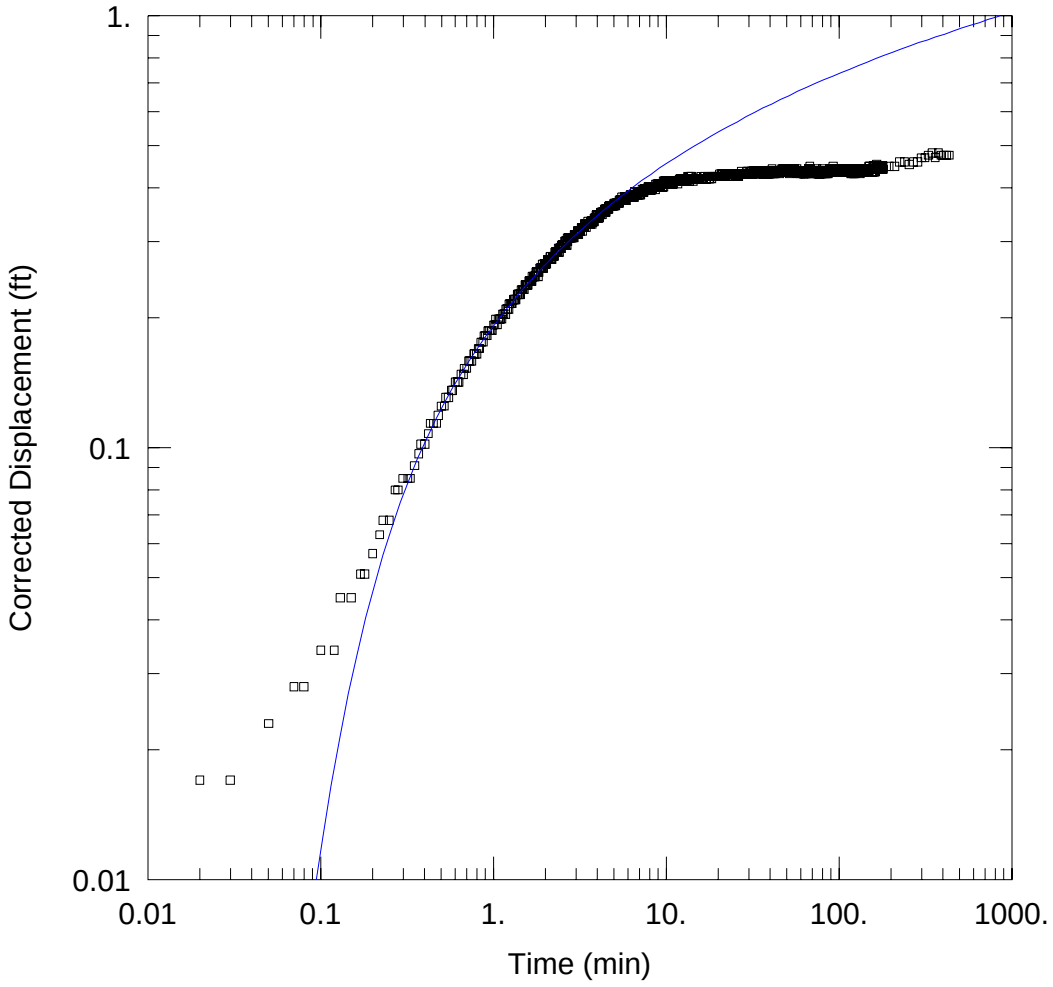
Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW-1D	138	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 4.993 ft^2/min
S = 0.0004361
Sy = 0.1
ß = 0.1



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\PW-2D Recovery\PW-1D recovery.aqt
Date: 09/12/17 Time: 15:33:32

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60306595
Location: Orleans, MA
Test Well: PW-
Test Date: 8/24/17

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
PW-2D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ PW-1D	138	0

SOLUTION

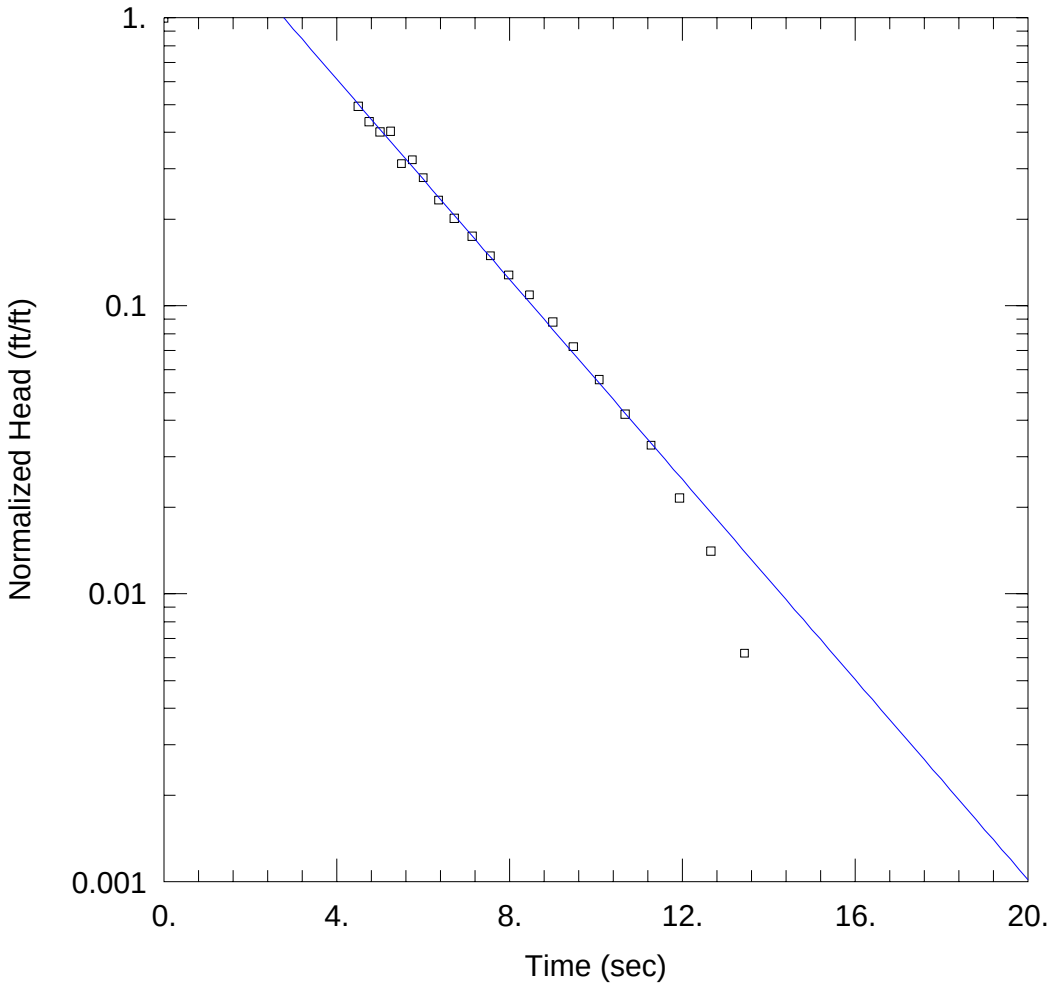
Aquifer Model: Unconfined
Solution Method: Theis

T = 7.086 ft^2/min
S = 0.0003077
Kz/Kr = 0.05251
b = 100. ft

Appendix J

Slug Test Analysis Reports

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WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run1 normalized.aqt
Date: 05/24/18 Time: 11:47:10

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

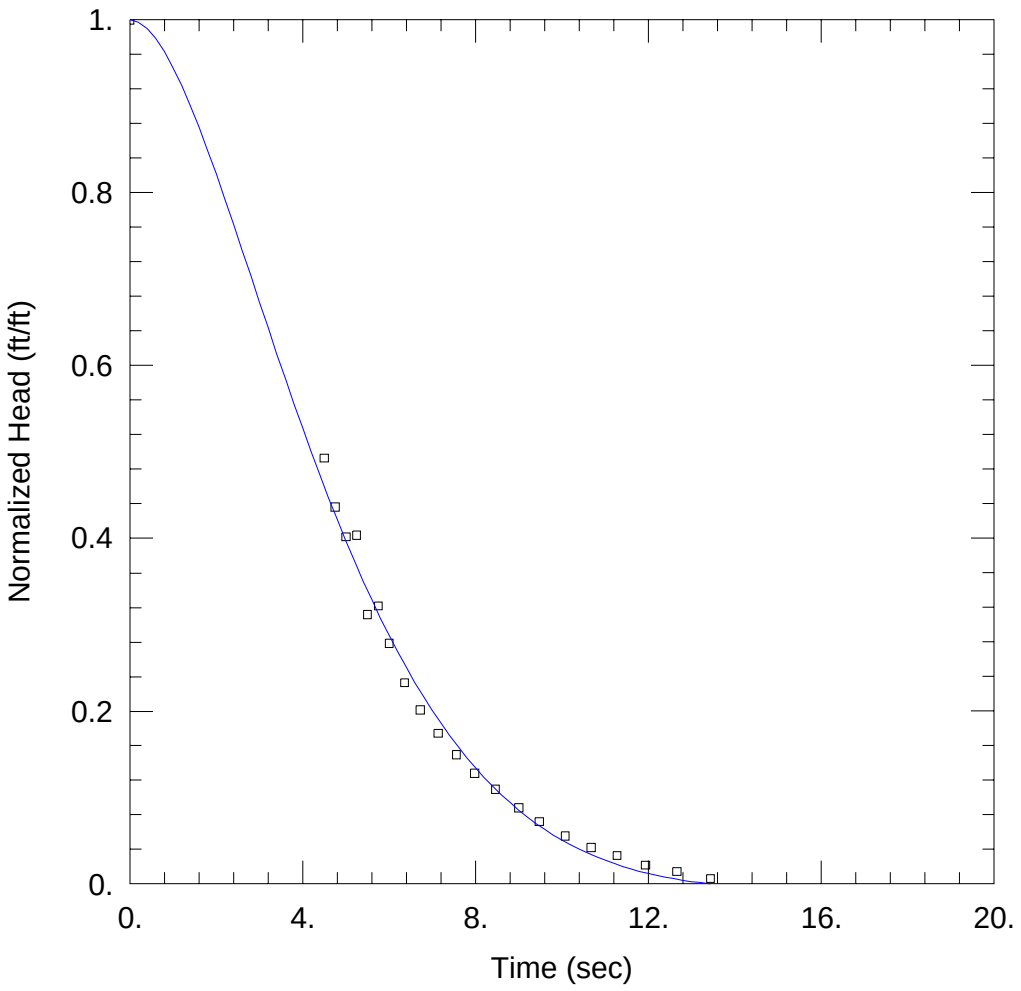
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.03 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 59.68 ft/day
y0 = 6.171 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run1 normalized.aqt
Date: 05/24/18 Time: 11:47:29

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

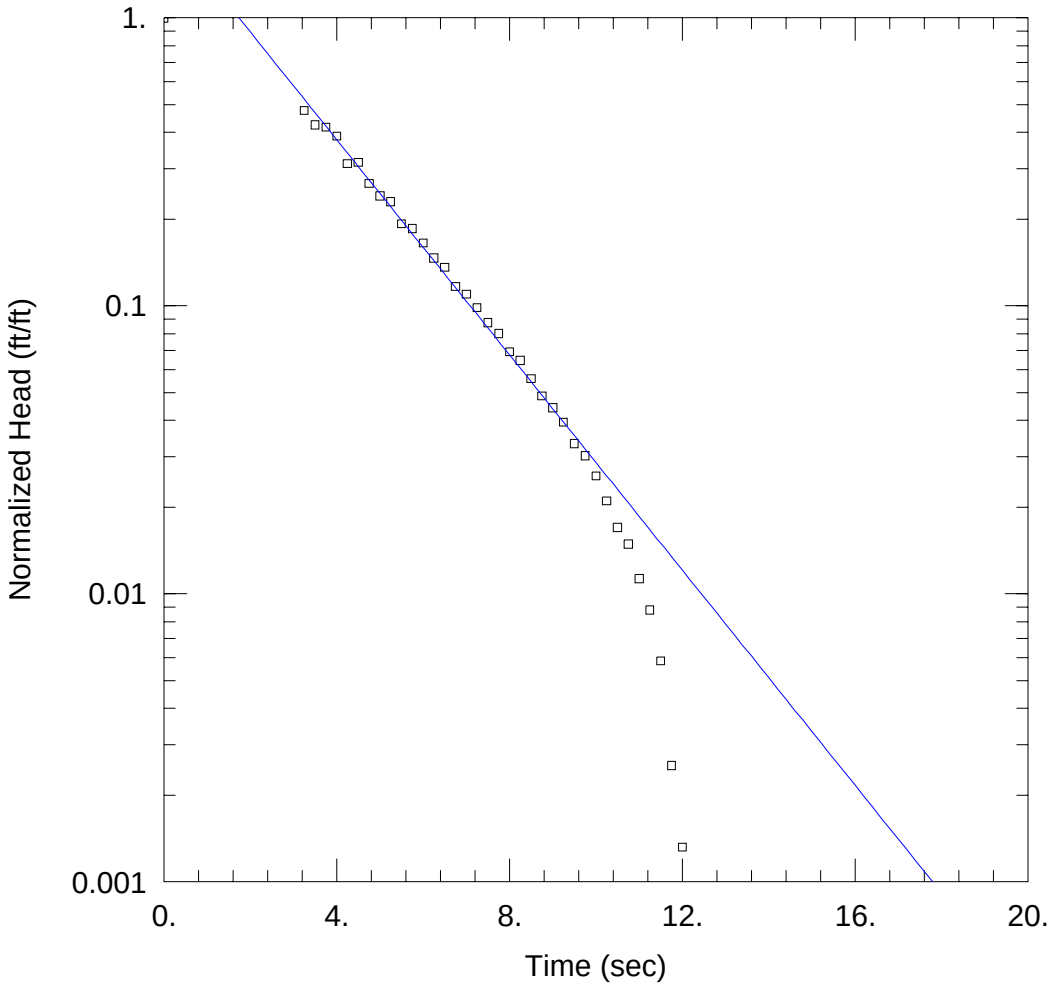
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.03 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 32.24 ft/day
Le = 237.2 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt
Date: 05/24/18 Time: 11:45:37

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

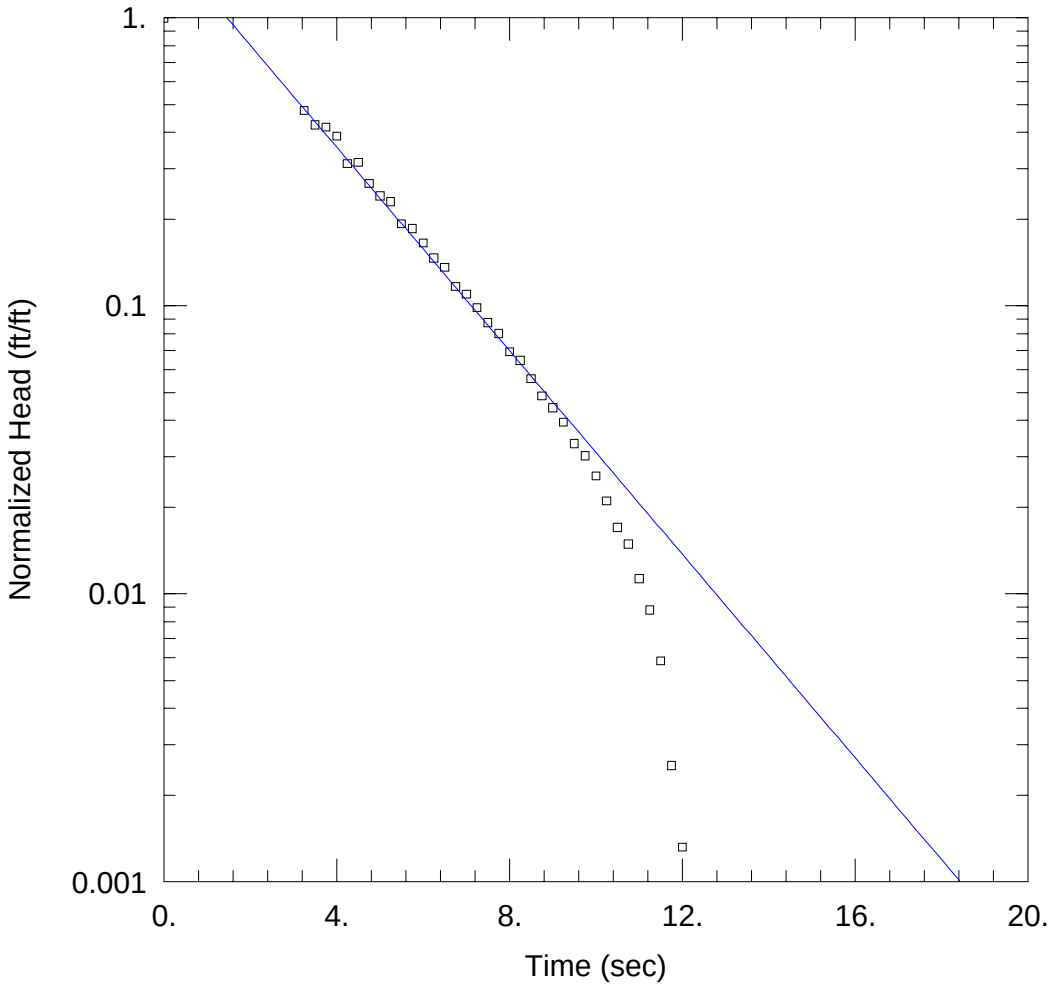
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.1 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 64.18 ft/day
y0 = 4.439 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt
Date: 05/24/18 Time: 11:46:08

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

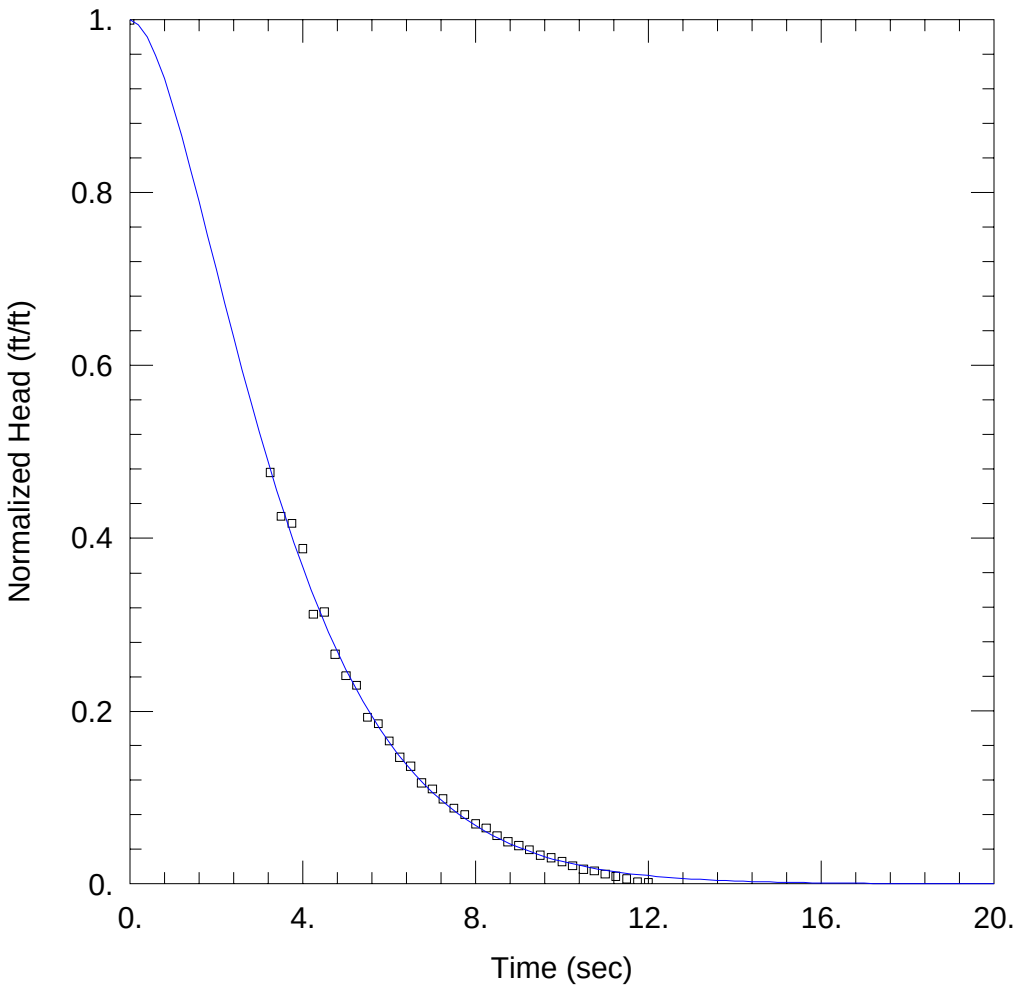
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.1 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 80.94 ft/day
y0 = 3.806 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run2 normalized.aqt
Date: 05/24/18 Time: 11:45:11

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

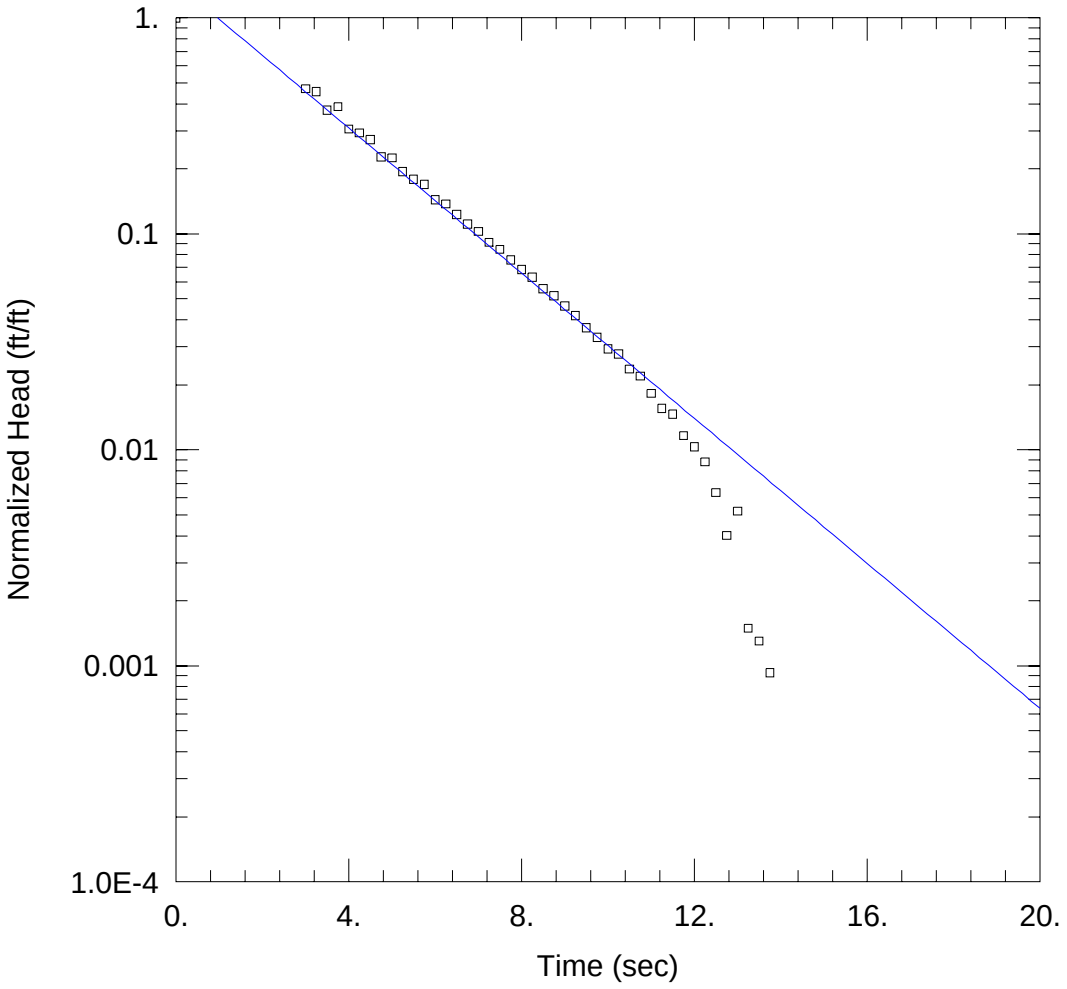
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.1 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 40.38 ft/day
Le = 115. ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt
Date: 05/24/18 Time: 11:48:15

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

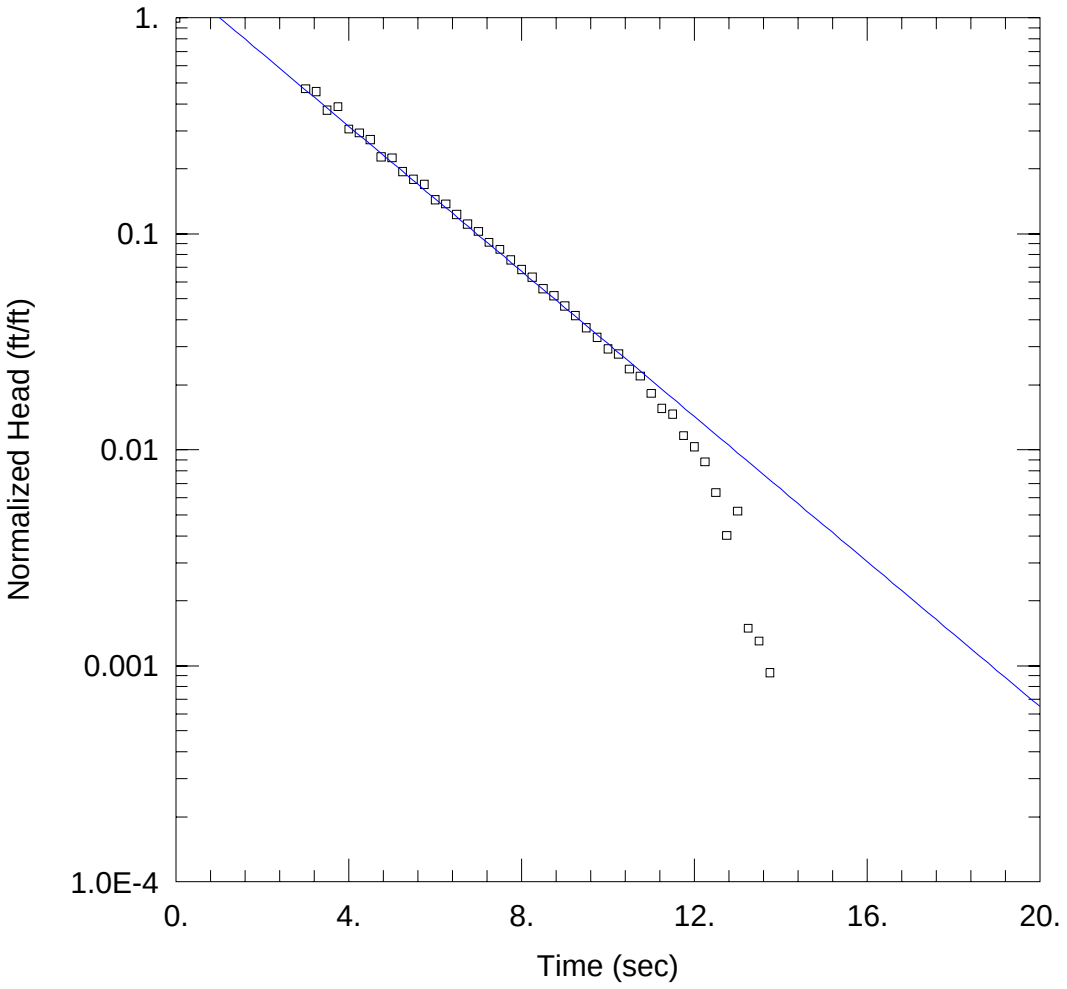
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.13 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 57.68 ft/day
y0 = 3.095 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt
Date: 05/24/18 Time: 11:47:56

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

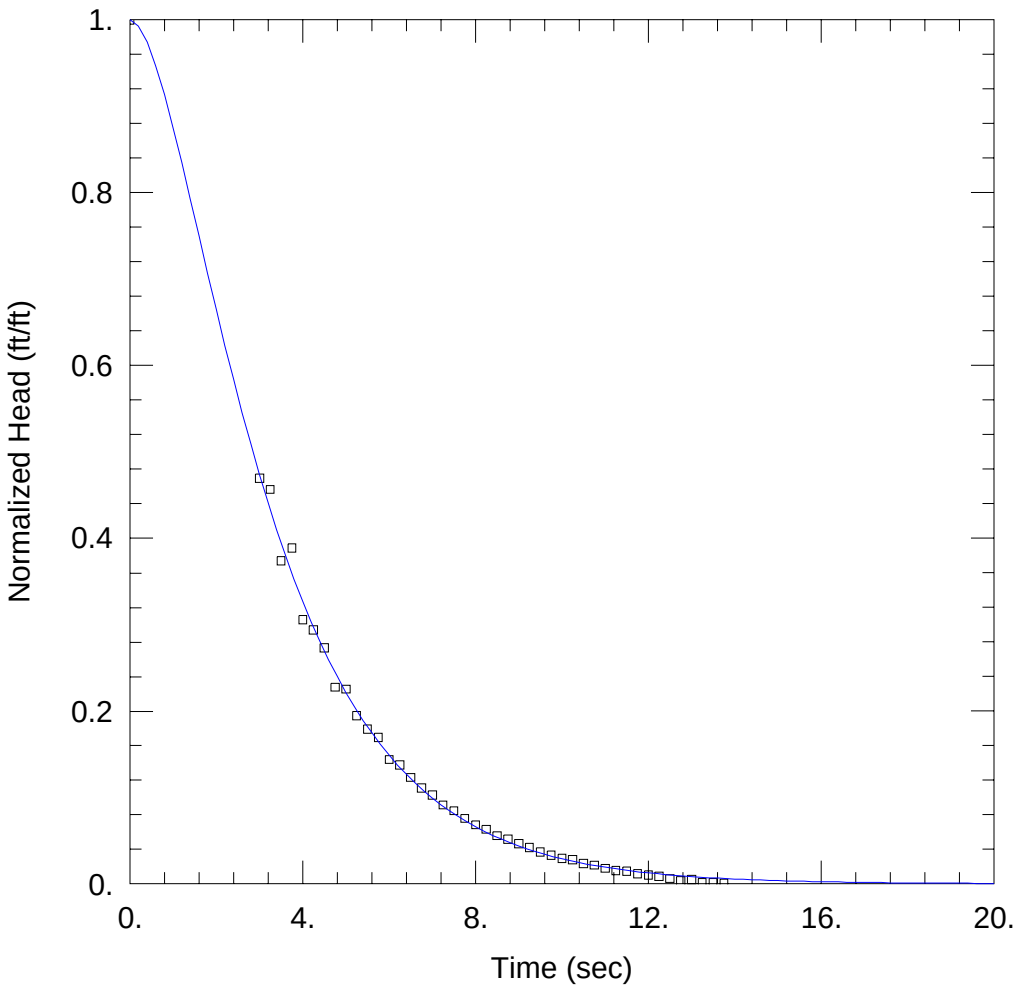
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.13 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 76.95 ft/day
y0 = 3.158 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-1 run3 normalized.aqt
Date: 05/24/18 Time: 11:48:51

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-1
Test Date: 6/7/17

AQUIFER DATA

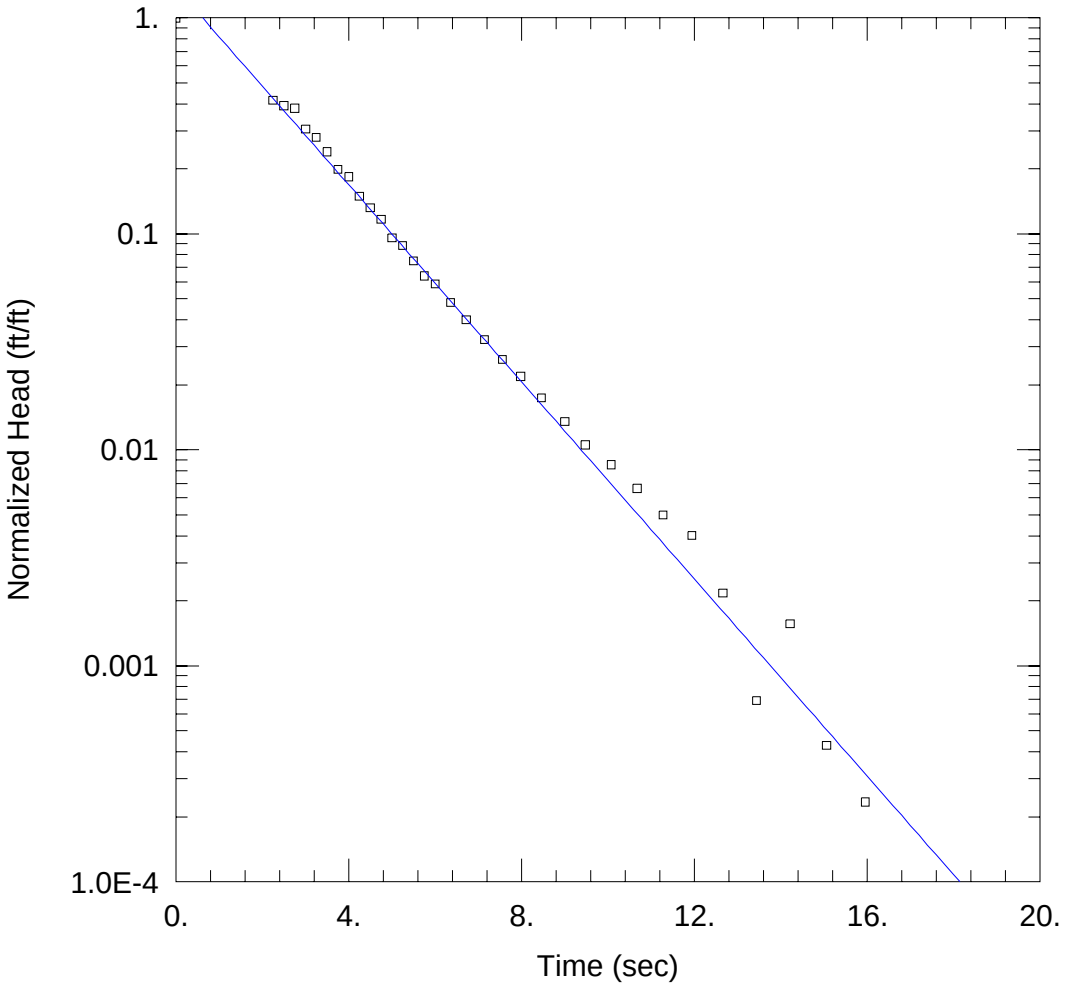
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-1)

Initial Displacement: 2.13 ft
Total Well Penetration Depth: 23. ft
Casing Radius: 0.1 ft
Static Water Column Height: 23. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 42.53 ft/day
Le = 84.64 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt
Date: 05/24/18 Time: 11:52:20

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

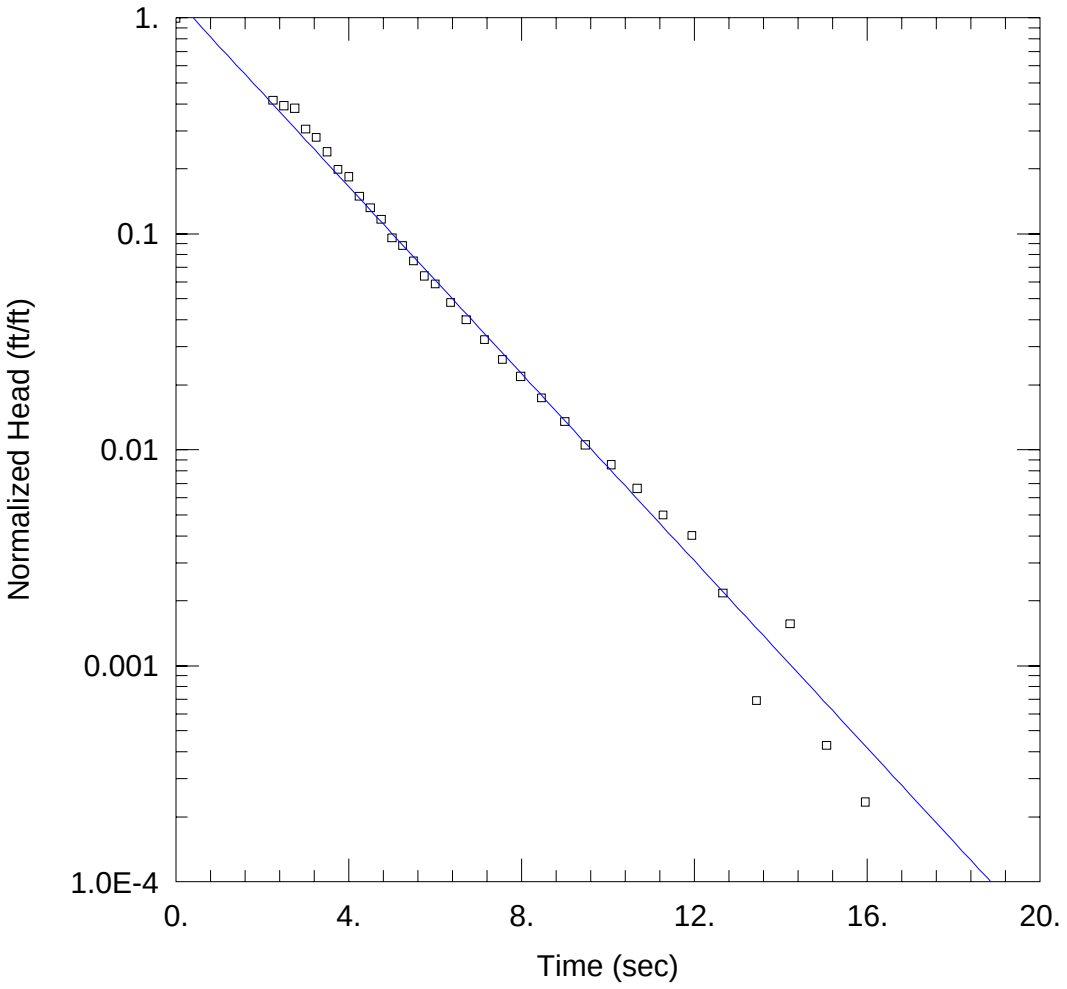
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.41 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 78.8 ft/day
y0 = 3.334 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt
Date: 05/24/18 Time: 11:52:40

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

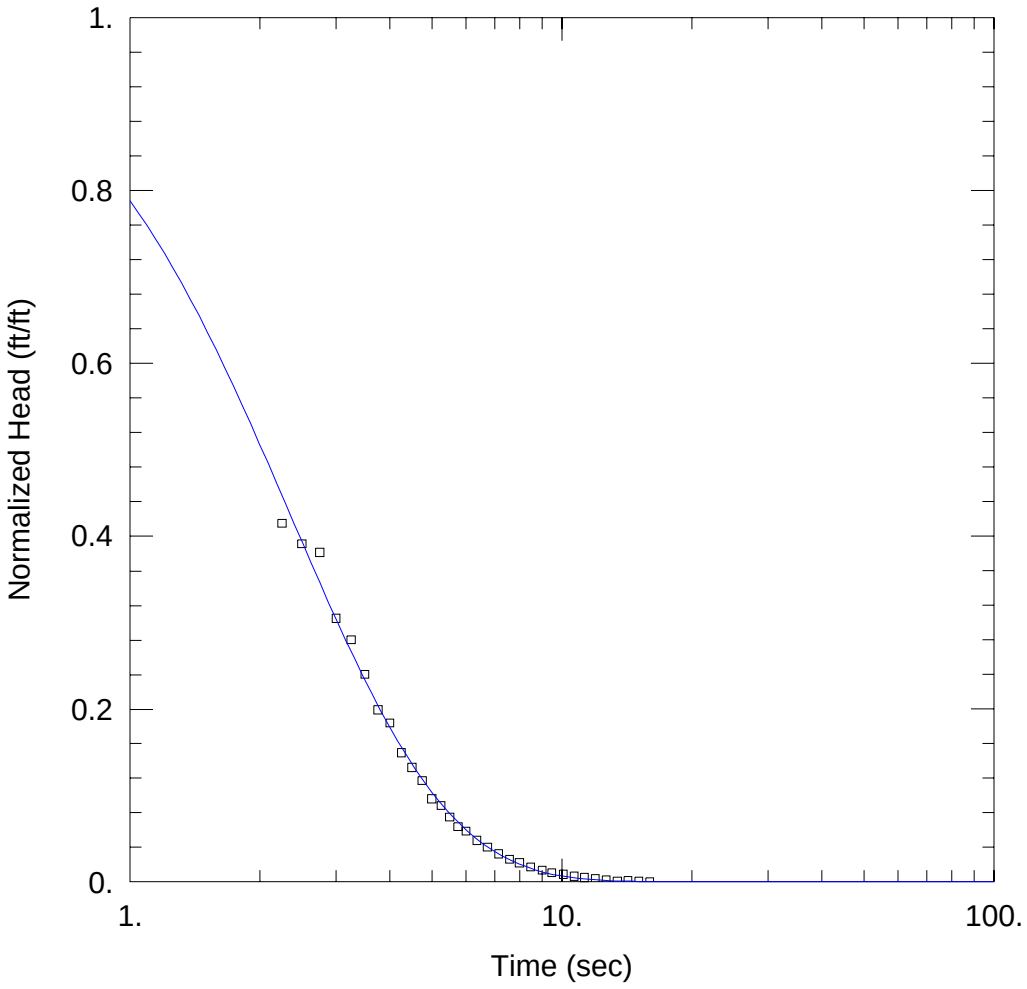
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.41 ft Static Water Column Height: 24. ft
Total Well Penetration Depth: 24. ft Screen Length: 10. ft
Casing Radius: 0.1 ft Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev
K = 99.22 ft/day y0 = 2.938 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run1 normalizd.aqt
Date: 05/24/18 Time: 11:51:46

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

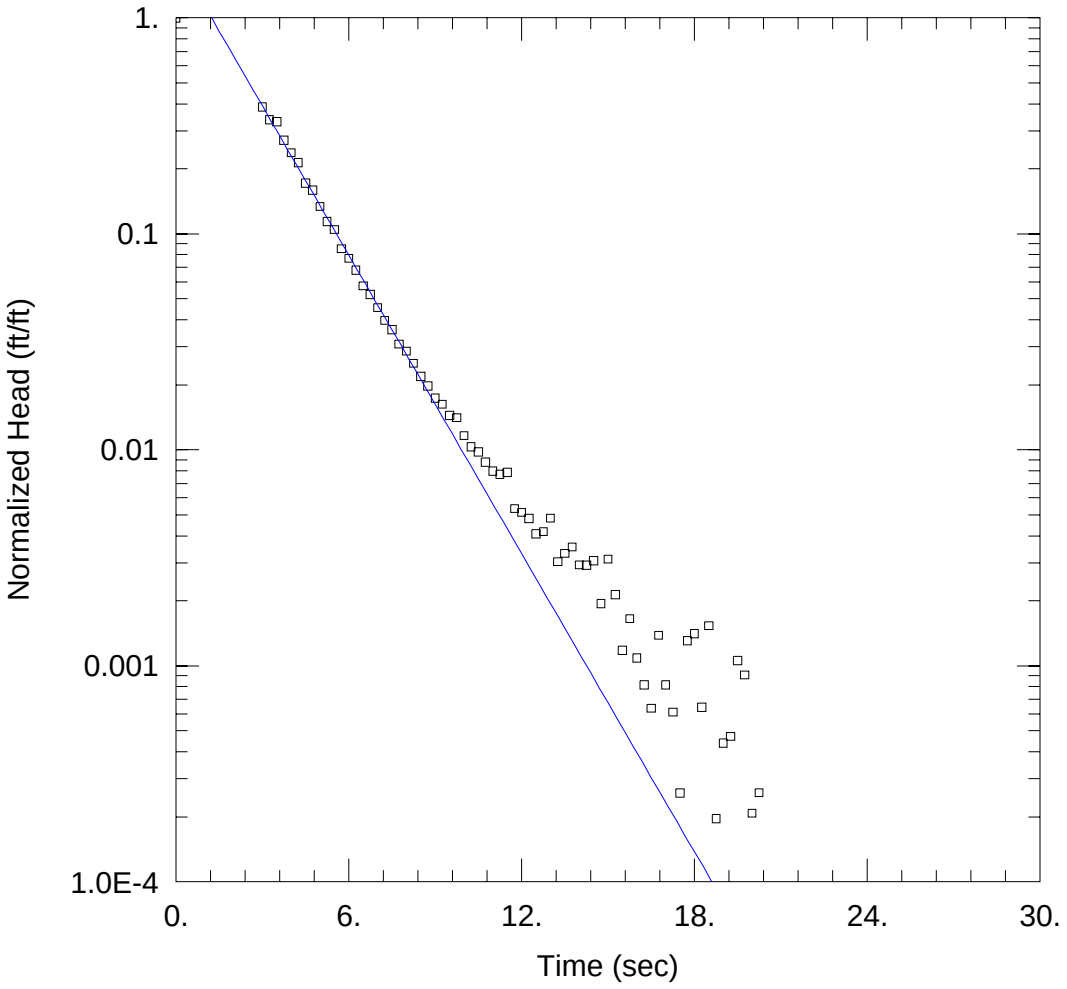
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.41 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 59.46 ft/day
Le = 41.1 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt
Date: 05/24/18 Time: 11:53:31

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

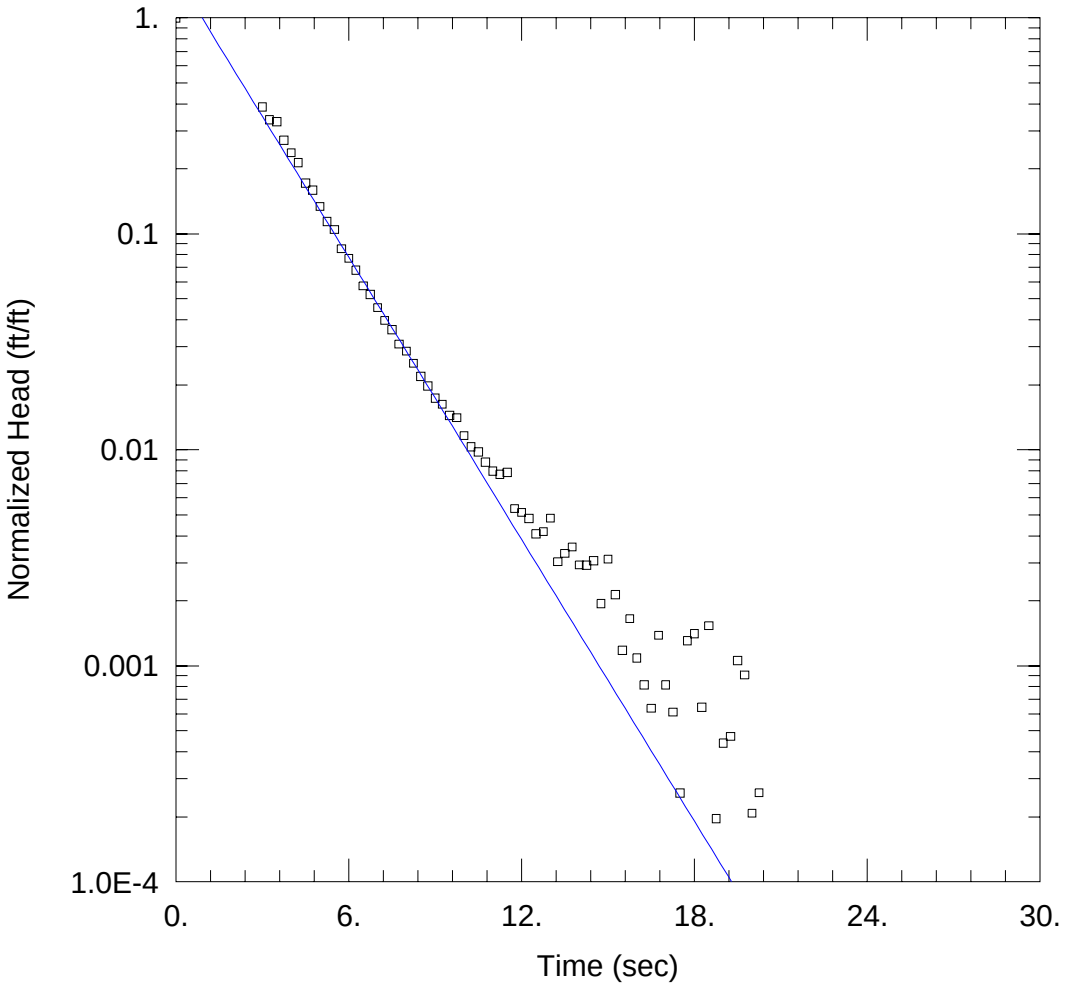
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.59 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 79.52 ft/day
y0 = 4.987 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt
Date: 05/24/18 Time: 11:54:16

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

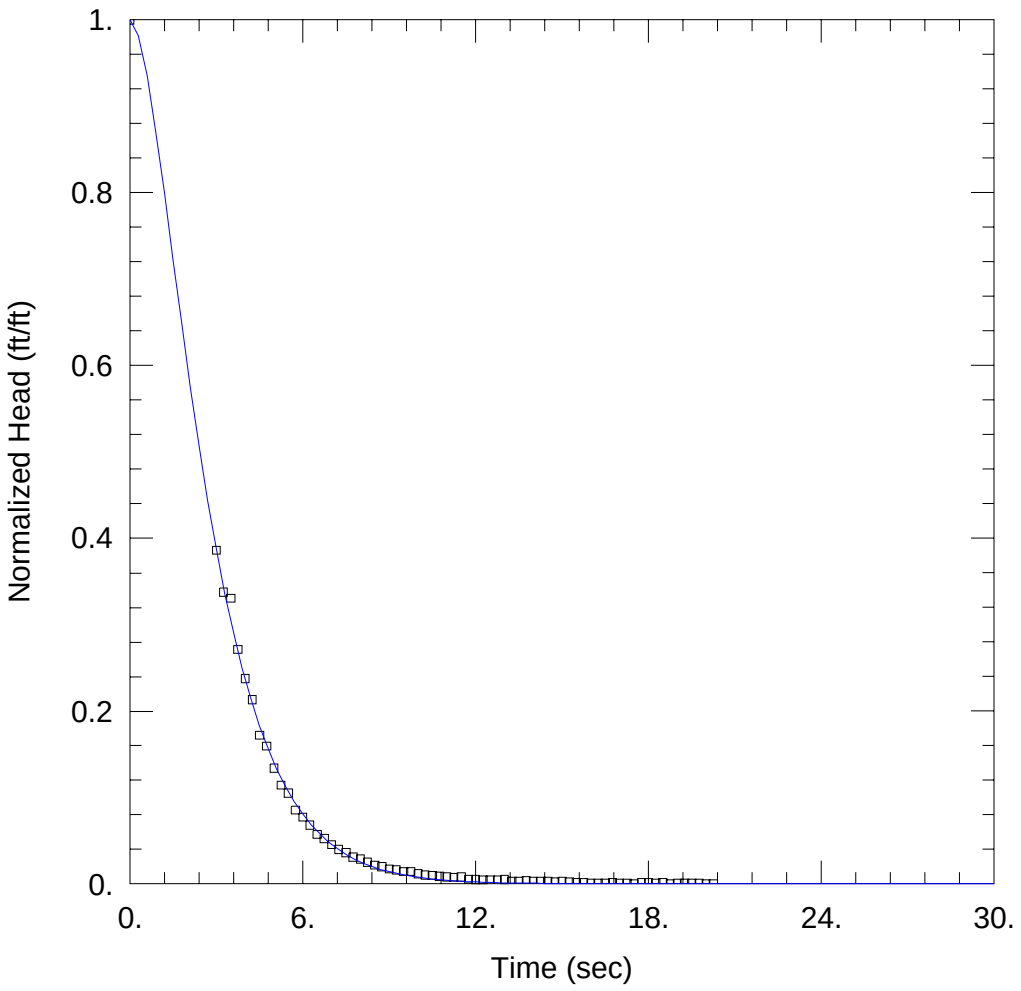
WELL DATA (LH-3)

Initial Displacement: 2.59 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 99.67 ft/day y0 = 4.088 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-3 Run2 normalized.aqt
Date: 05/24/18 Time: 11:53:11

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

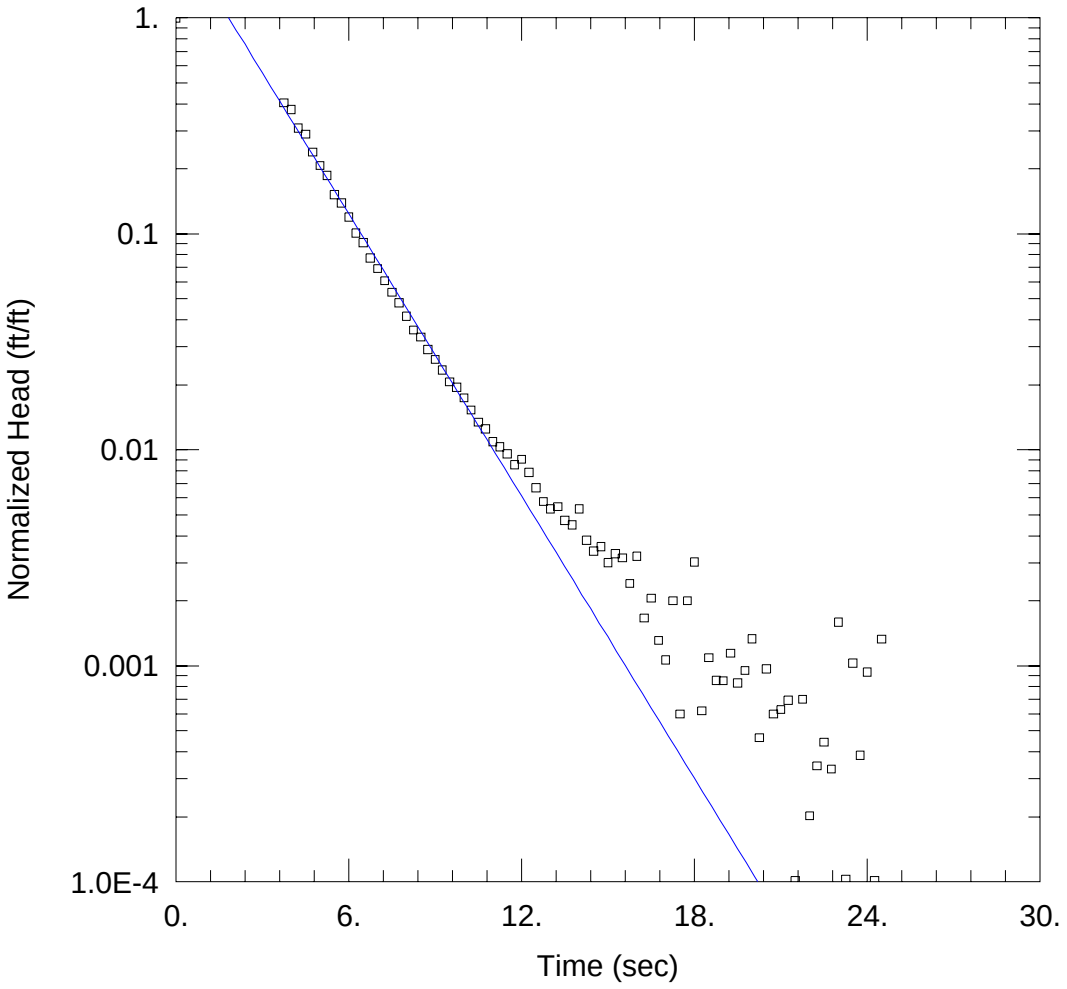
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.59 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 51.81 ft/day
Le = 68. ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt
Date: 05/24/18 Time: 11:54:42

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

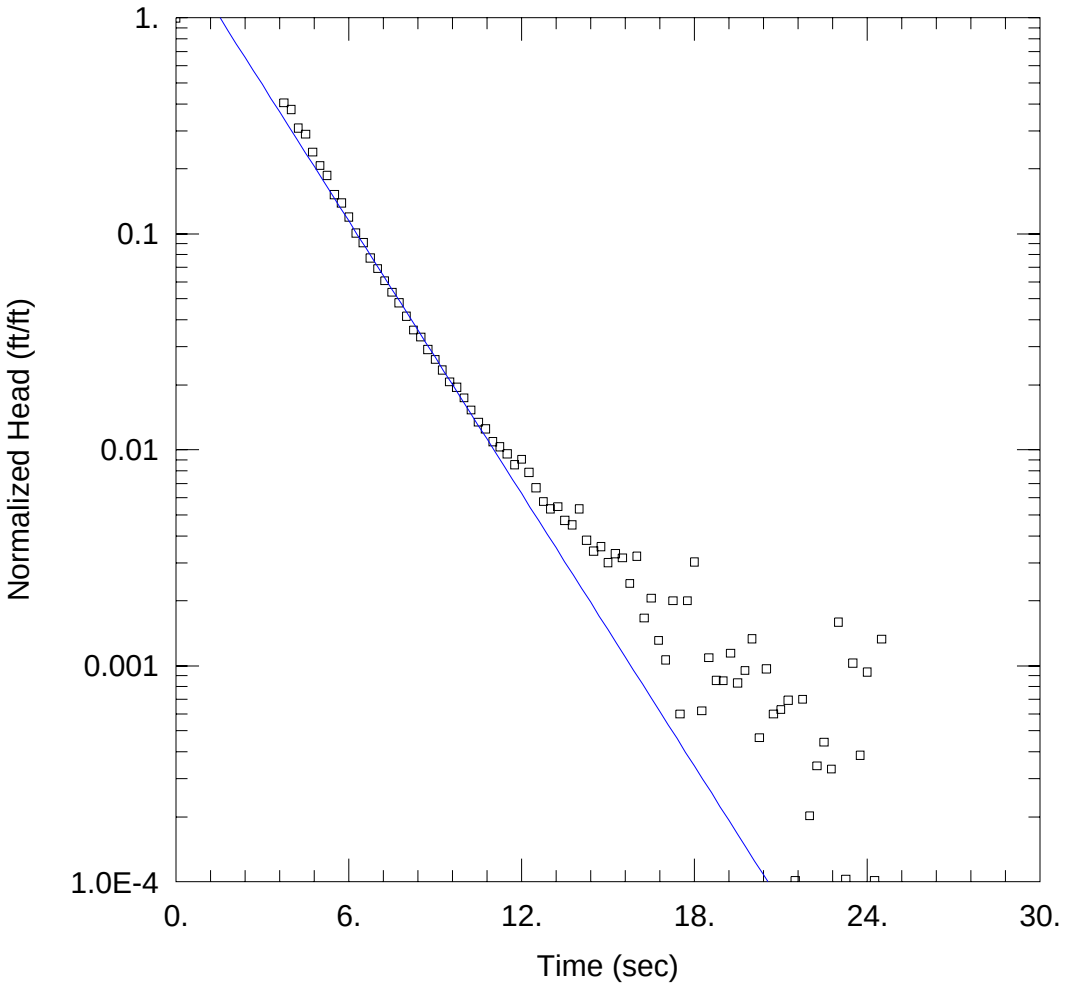
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.47 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 75.2 ft/day
y0 = 6.21 ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt
Date: 05/24/18 Time: 11:55:04

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

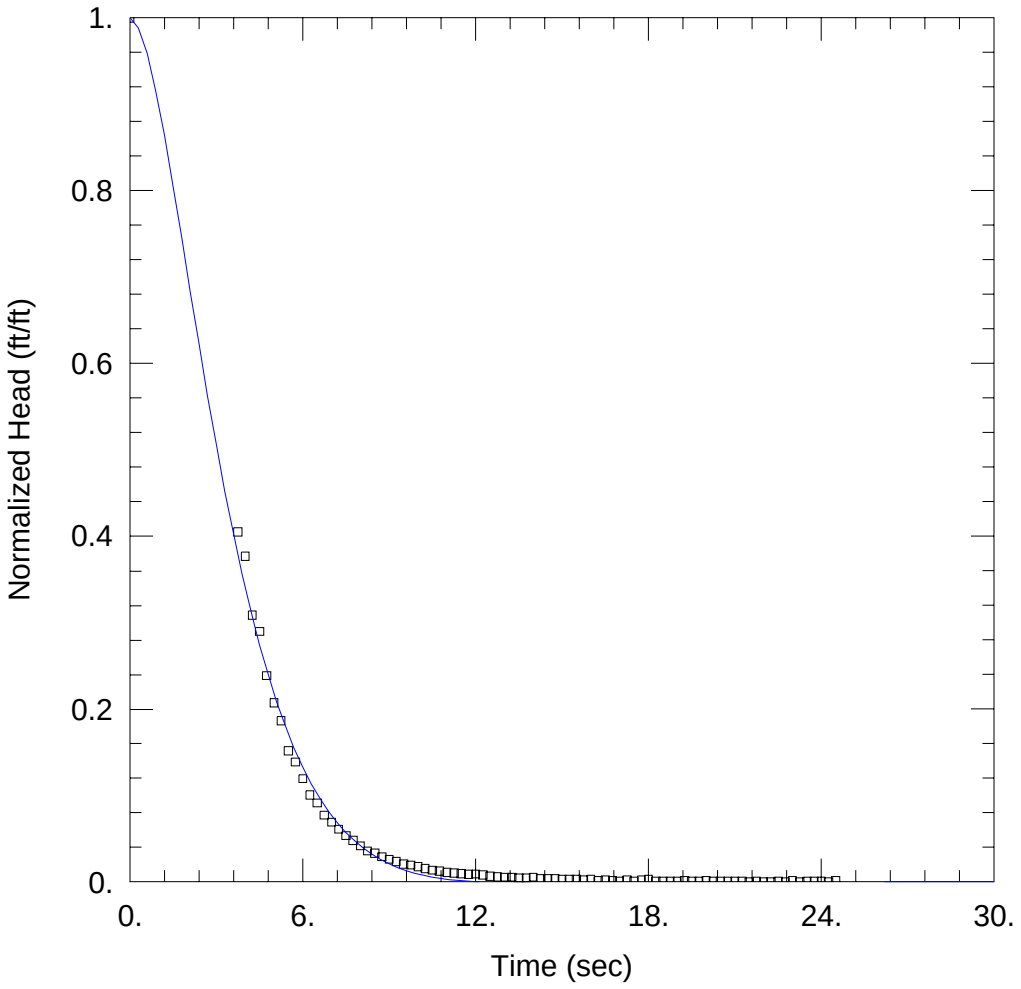
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.47 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 96.32 ft/day
y0 = 5.185 ft



WELL TEST ANALYSIS

Data Set: C:\Users\Erika.Amir-Lin\Desktop\Orleans Files\Slug Tests\Feb 2018\LH-3\LH-3 Run3.aqt
Date: 05/24/18 Time: 11:55:27

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

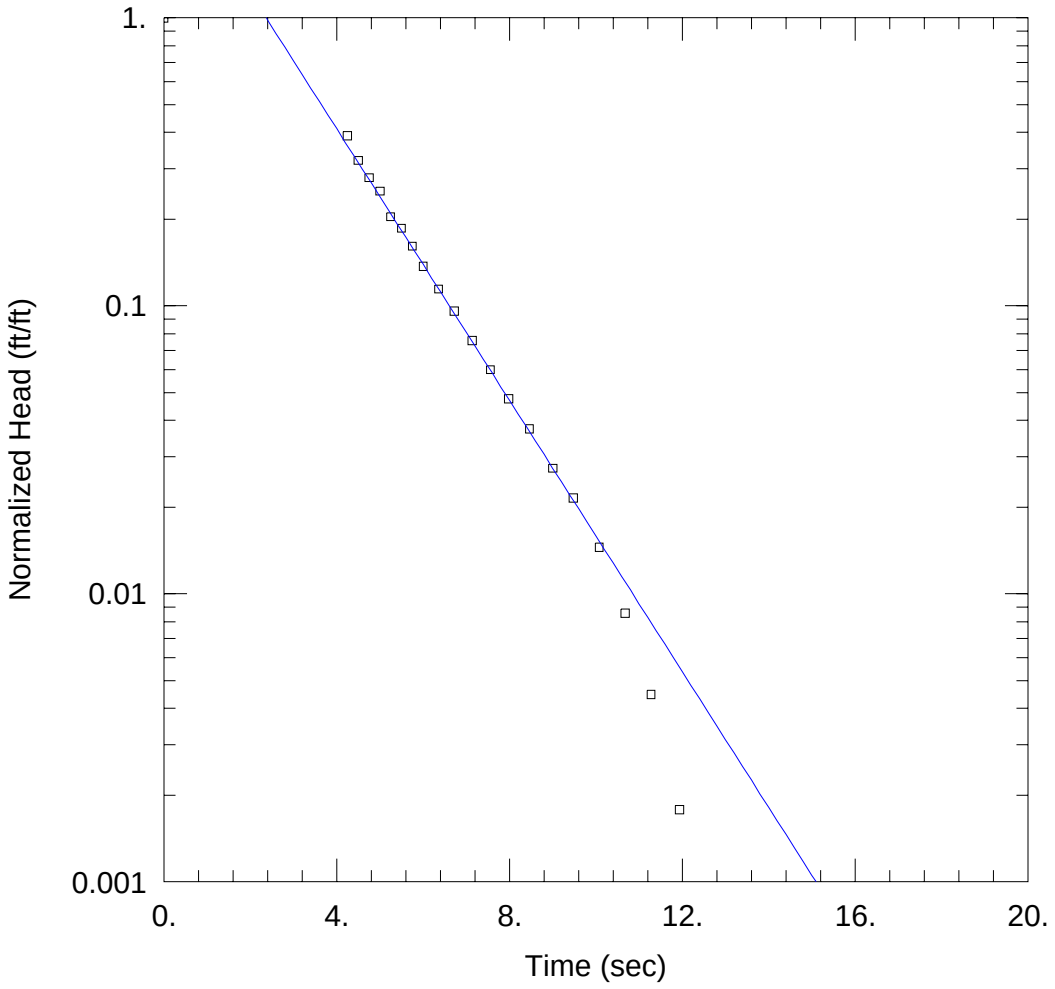
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-3)

Initial Displacement: 2.47 ft
Total Well Penetration Depth: 24. ft
Casing Radius: 0.1 ft
Static Water Column Height: 24. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 43.49 ft/day
Le = 116.7 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt
Date: 05/24/18 Time: 11:56:59

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

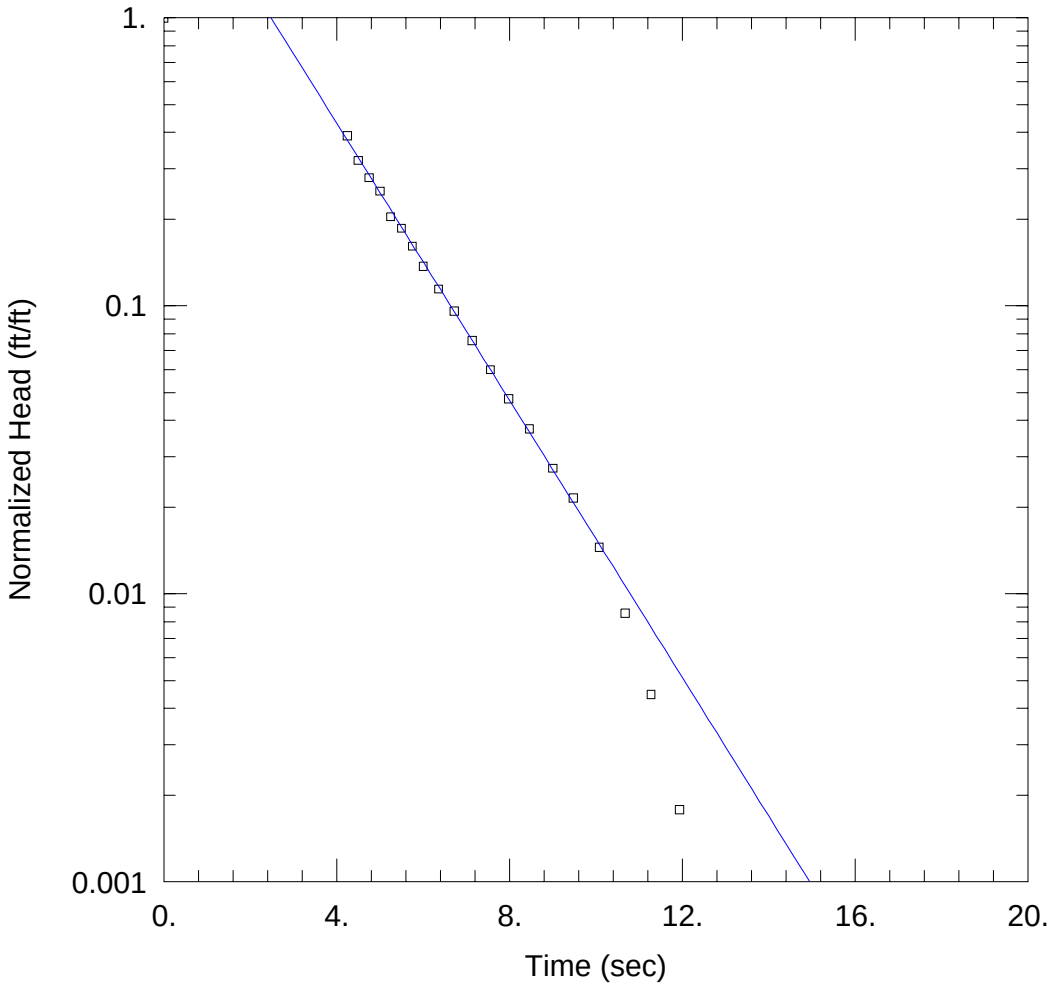
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft Static Water Column Height: 21. ft
Total Well Penetration Depth: 21. ft Screen Length: 10. ft
Casing Radius: 0.1 ft Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 79.99 ft/day y0 = 9.286 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt
Date: 05/24/18 Time: 11:57:22

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

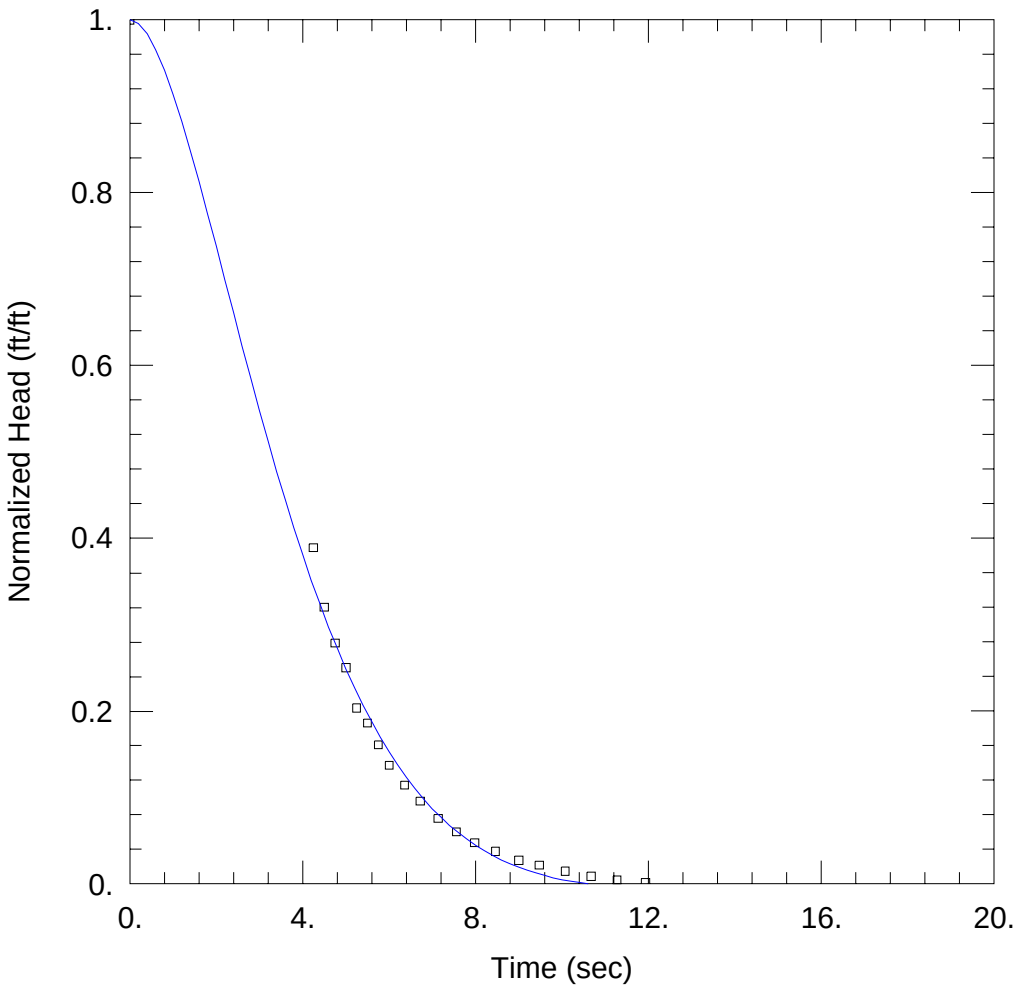
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft Static Water Column Height: 21. ft
Total Well Penetration Depth: 21. ft Screen Length: 10. ft
Casing Radius: 0.1 ft Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev
K = 110.2 ft/day y0 = 10.18 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run1 normalized.aqt
Date: 05/24/18 Time: 11:58:36

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

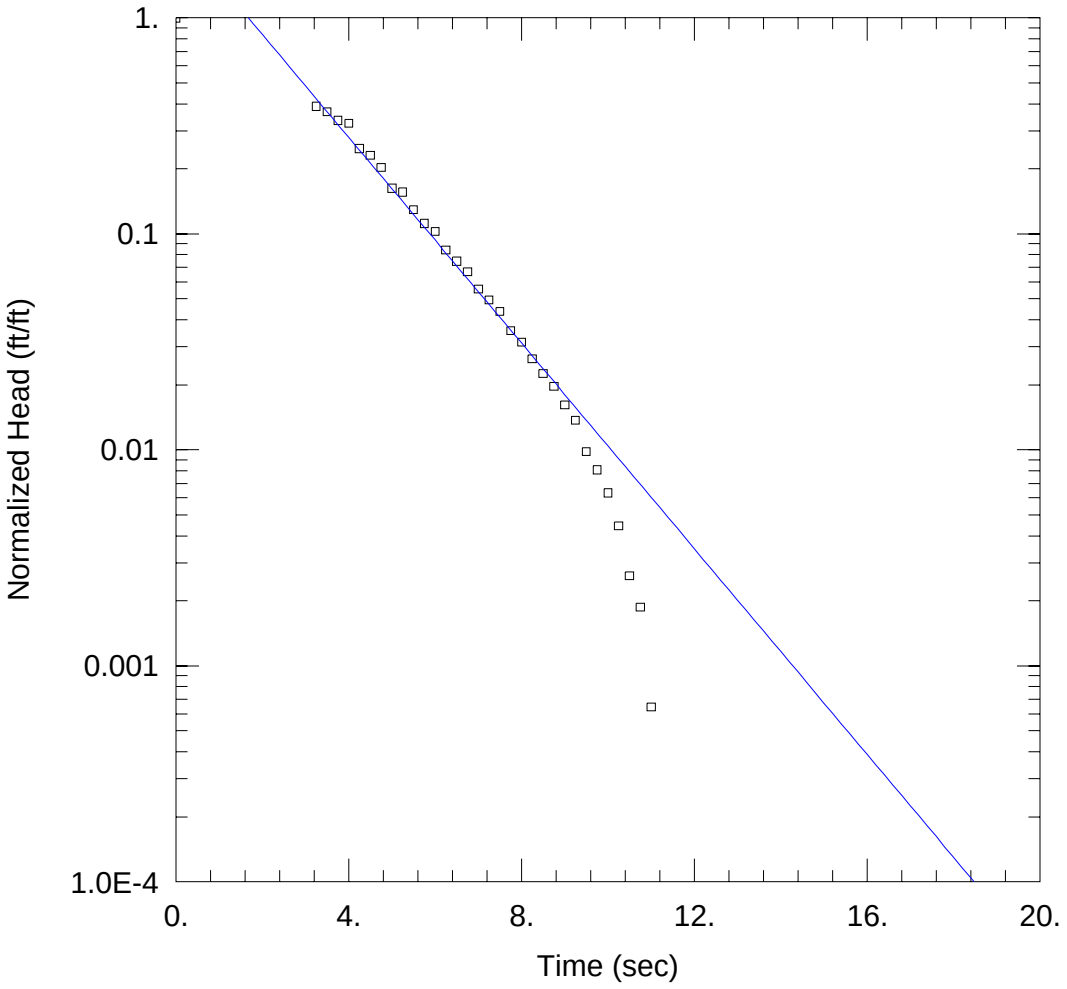
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 40.83 ft/day
Le = 143. ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt
Date: 05/24/18 Time: 11:59:18

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

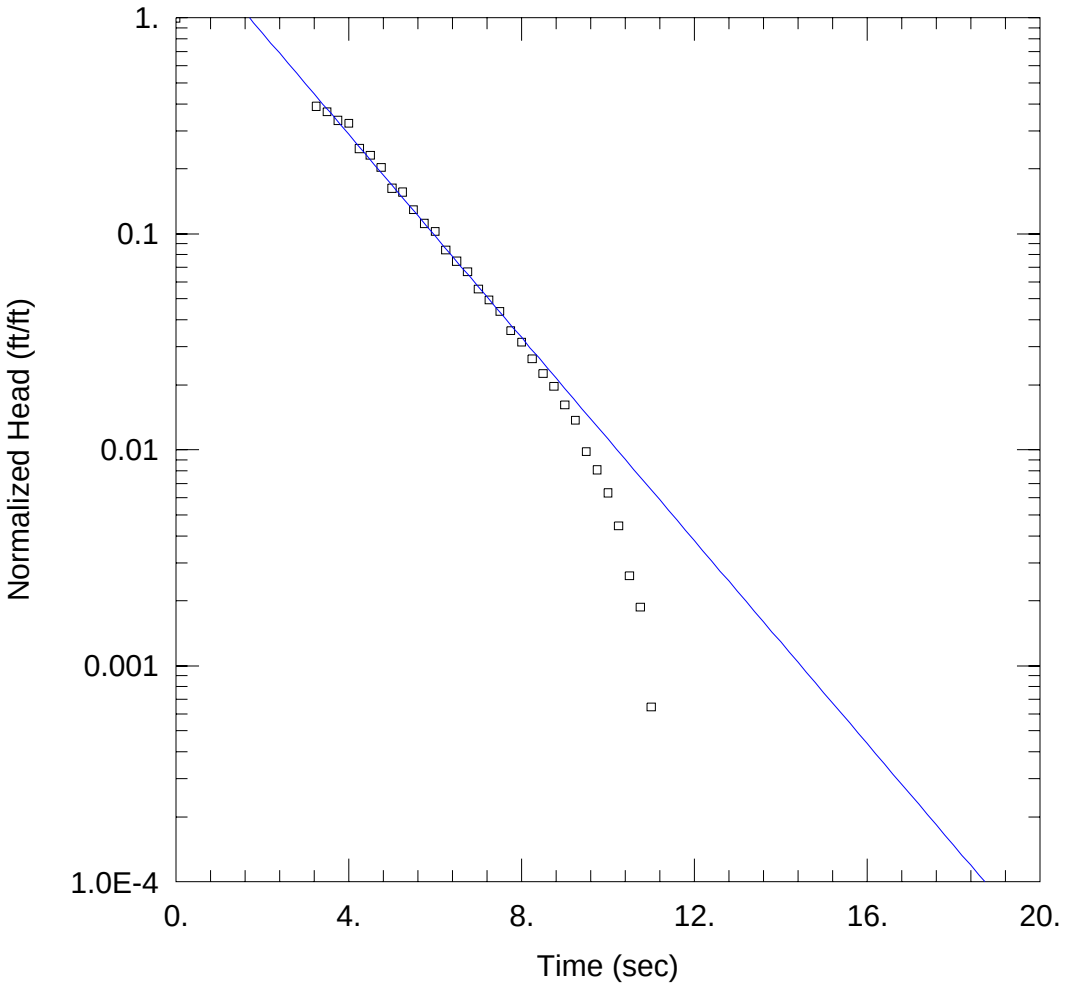
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft Static Water Column Height: 21. ft
Total Well Penetration Depth: 21. ft Screen Length: 10. ft
Casing Radius: 0.1 ft Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 80.81 ft/day y0 = 6.449 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt
Date: 05/24/18 Time: 11:59:40

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

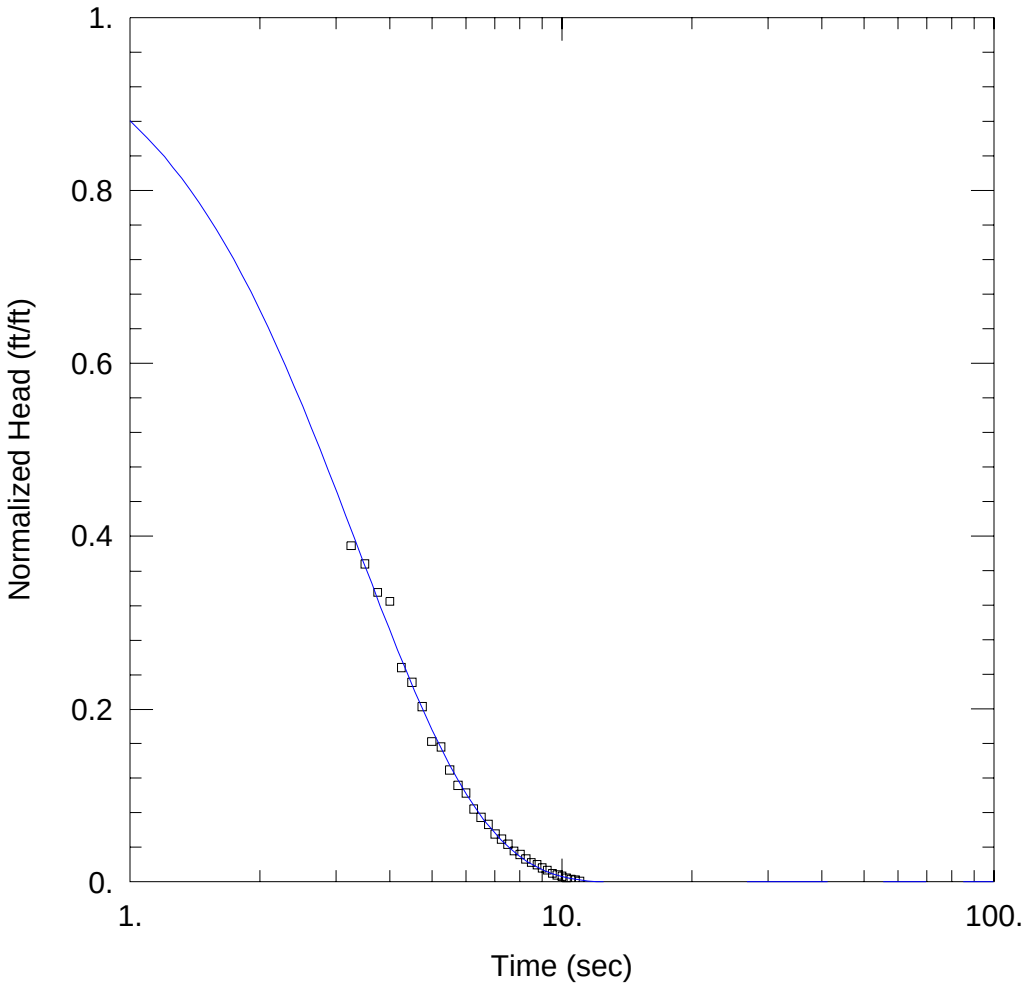
WELL DATA (LH-5)

Initial Displacement: 2.57 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 107.7 ft/day y0 = 6.473 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run2 normalized.aqt
Date: 05/24/18 Time: 11:58:52

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

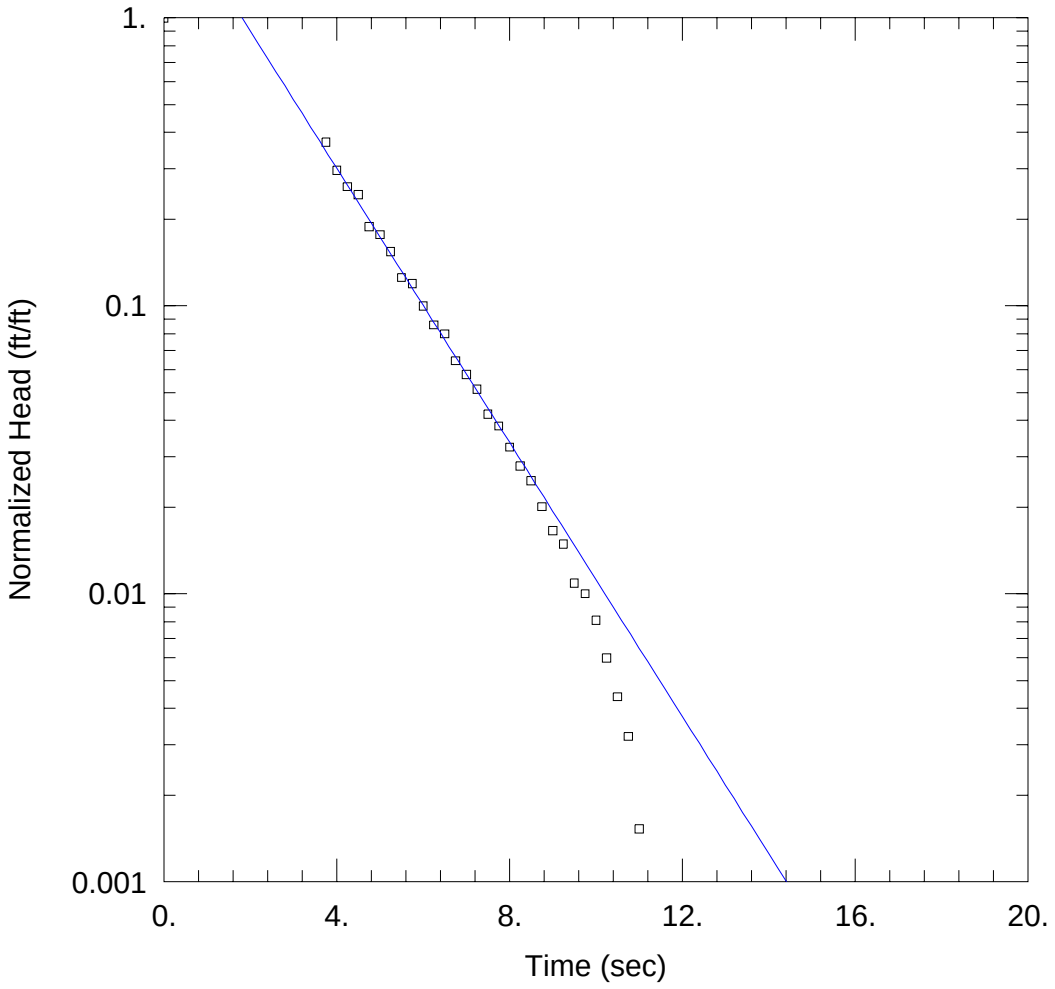
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.57 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 46.47 ft/day
Le = 94.49 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt
Date: 05/24/18 Time: 12:01:13

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

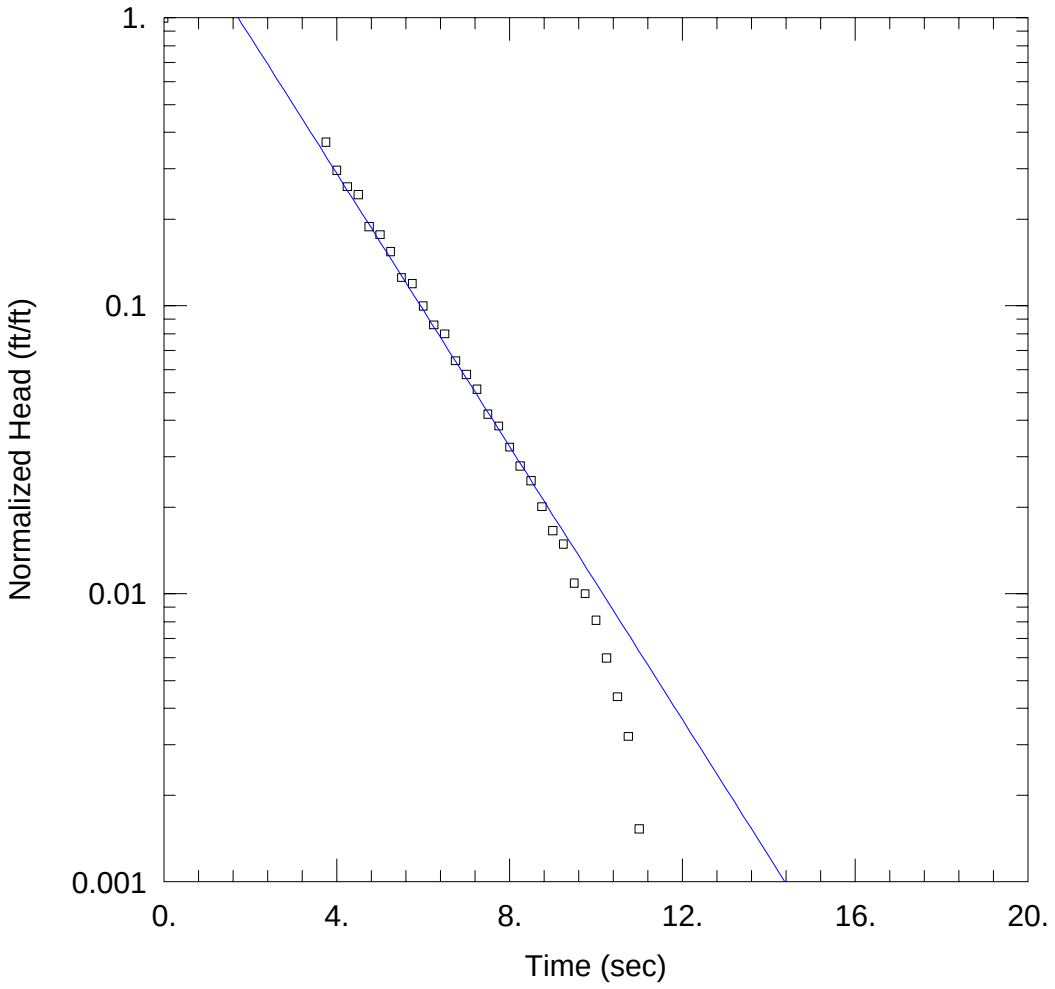
WELL DATA (LH-5)

Initial Displacement: 2.7 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 80.78 ft/day y0 = 7.275 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt
Date: 05/24/18 Time: 12:01:38

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

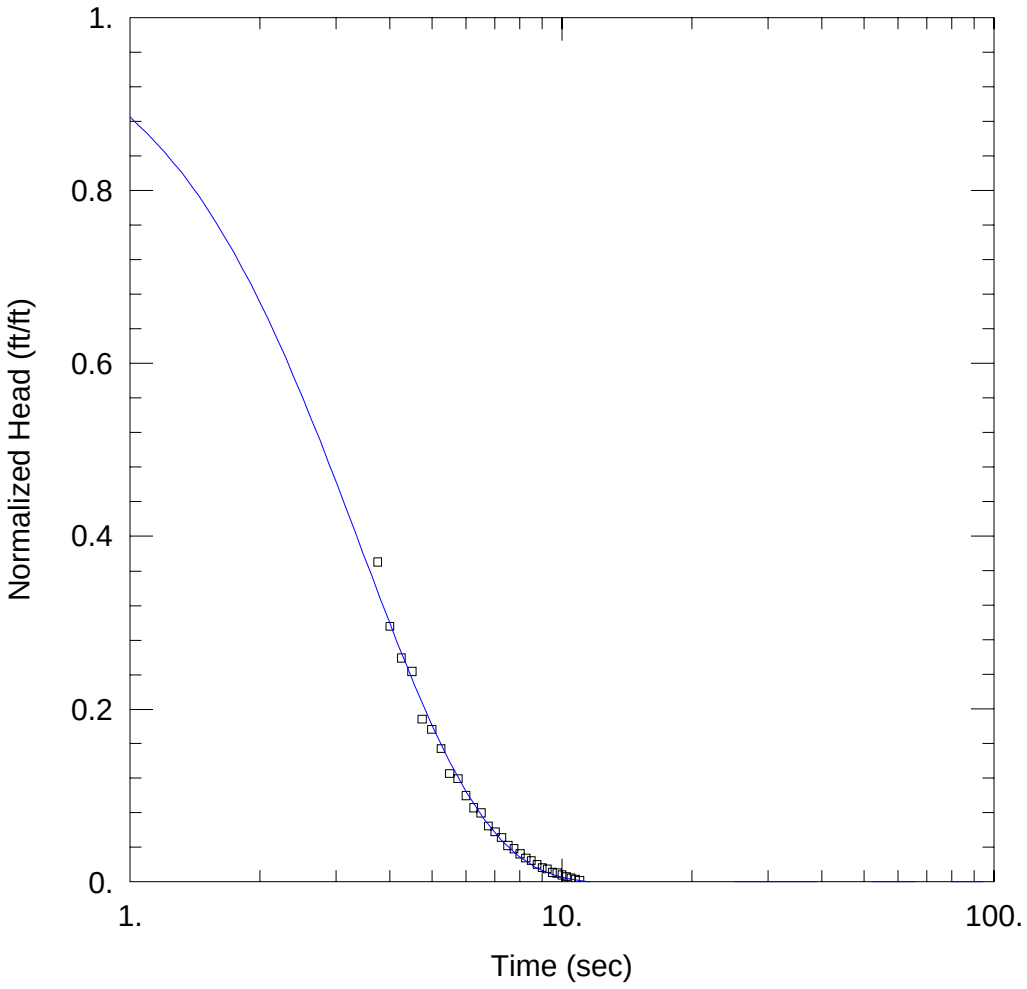
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (LH-5)

Initial Displacement: 2.7 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 108.6 ft/day
y0 = 6.916 ft



WELL TEST ANALYSIS

Data Set: C:\...\LH-5 Run3 normalized.aqt
Date: 05/24/18 Time: 12:00:00

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: LH-3
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

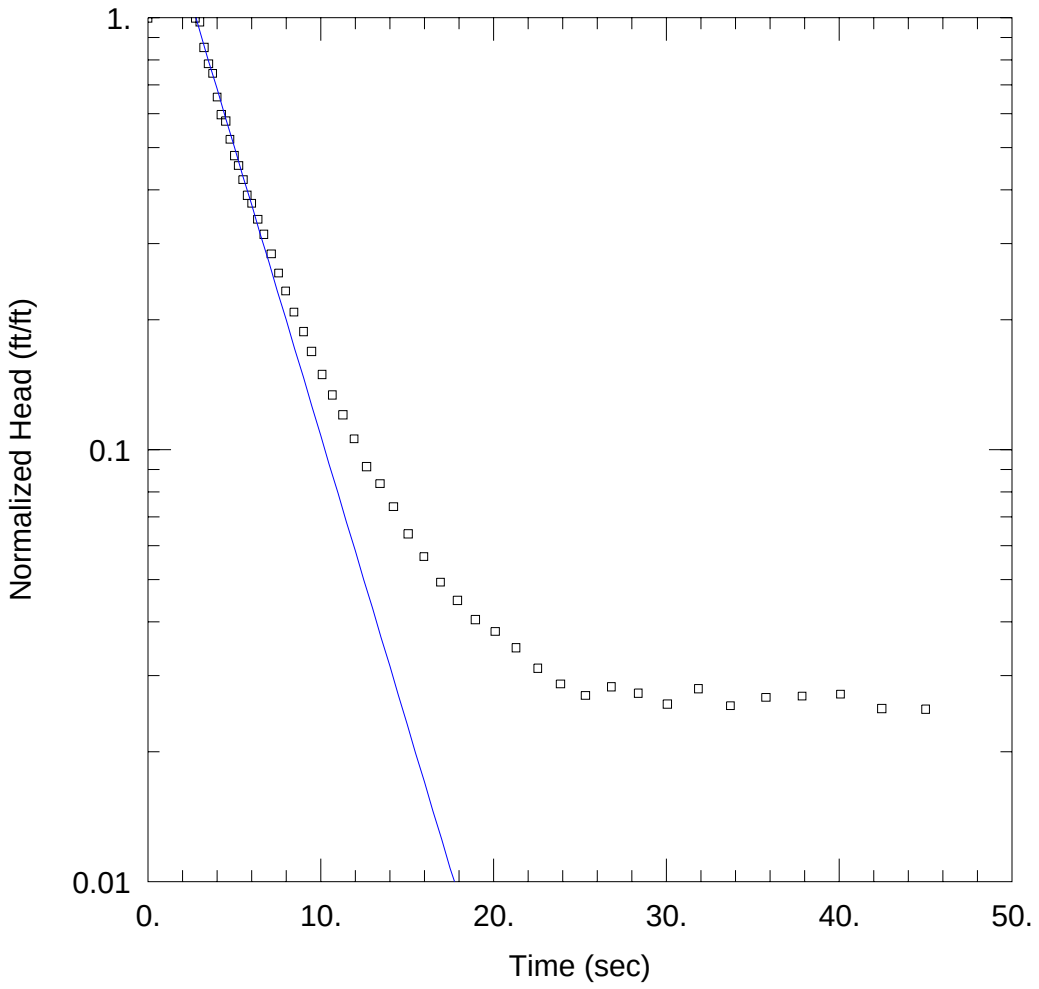
WELL DATA (LH-5)

Initial Displacement: 2.7 ft
Total Well Penetration Depth: 21. ft
Casing Radius: 0.1 ft
Static Water Column Height: 21. ft
Screen Length: 10. ft
Well Radius: 0.1 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 45.98 ft/day
Le = 99.45 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt
Date: 05/24/18 Time: 12:07:02

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

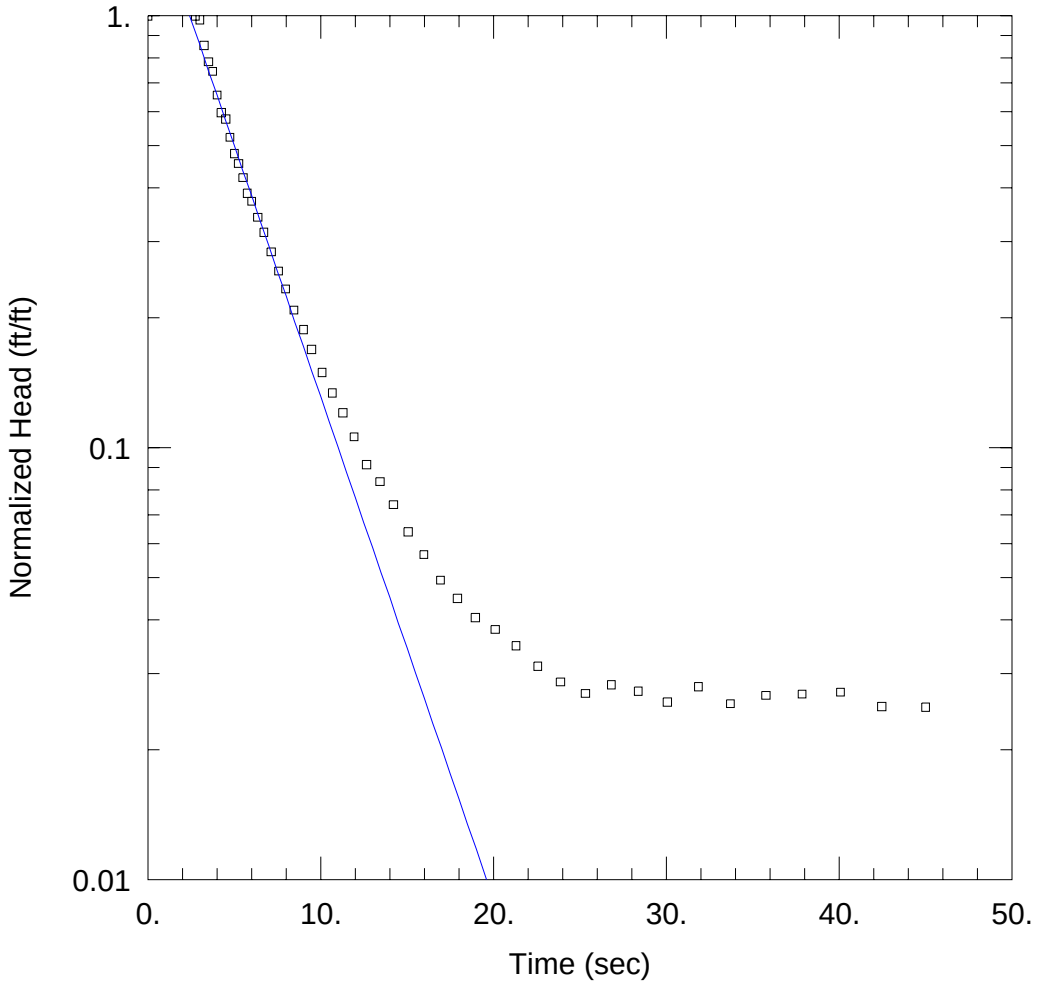
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 34.45 ft/day
y0 = 2.345 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt
Date: 05/24/18 Time: 12:07:43

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

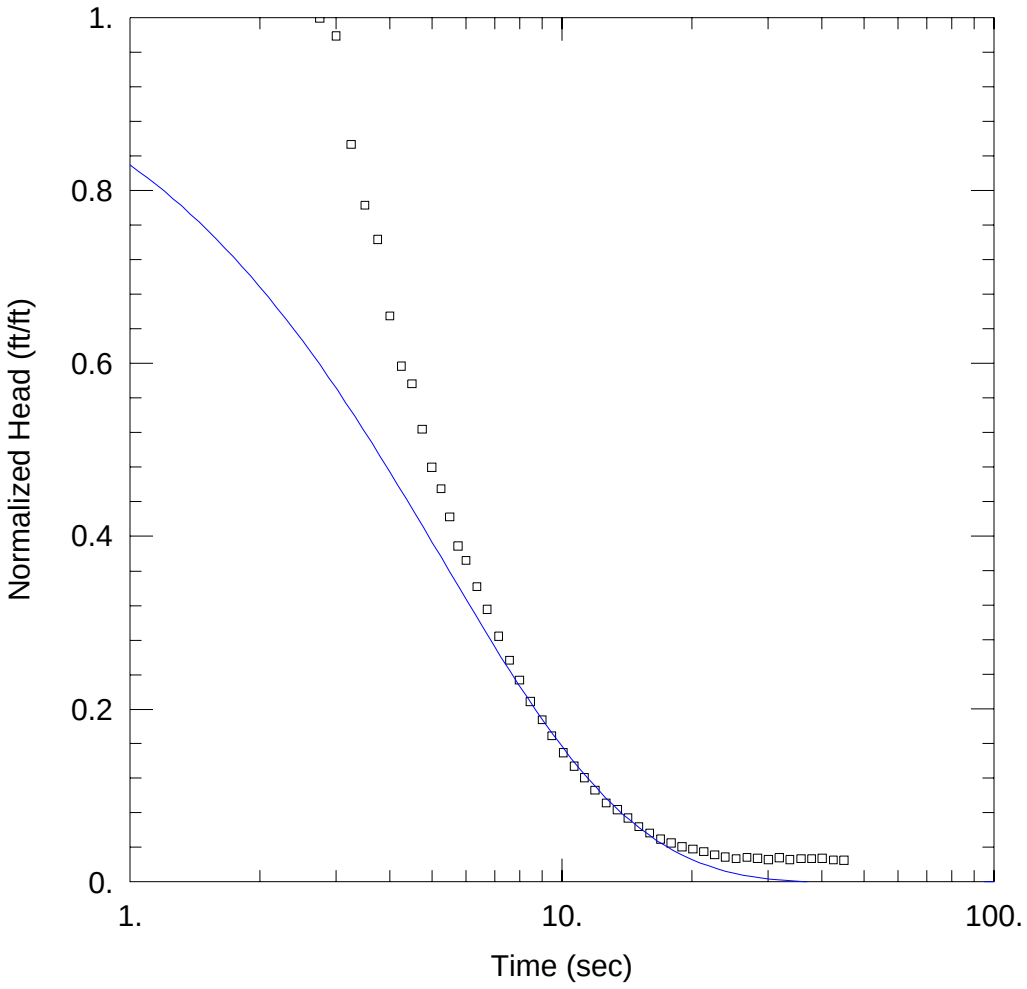
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 38.21 ft/day y0 = 1.916 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run1 normalized.aqt
Date: 05/24/18 Time: 12:08:27

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

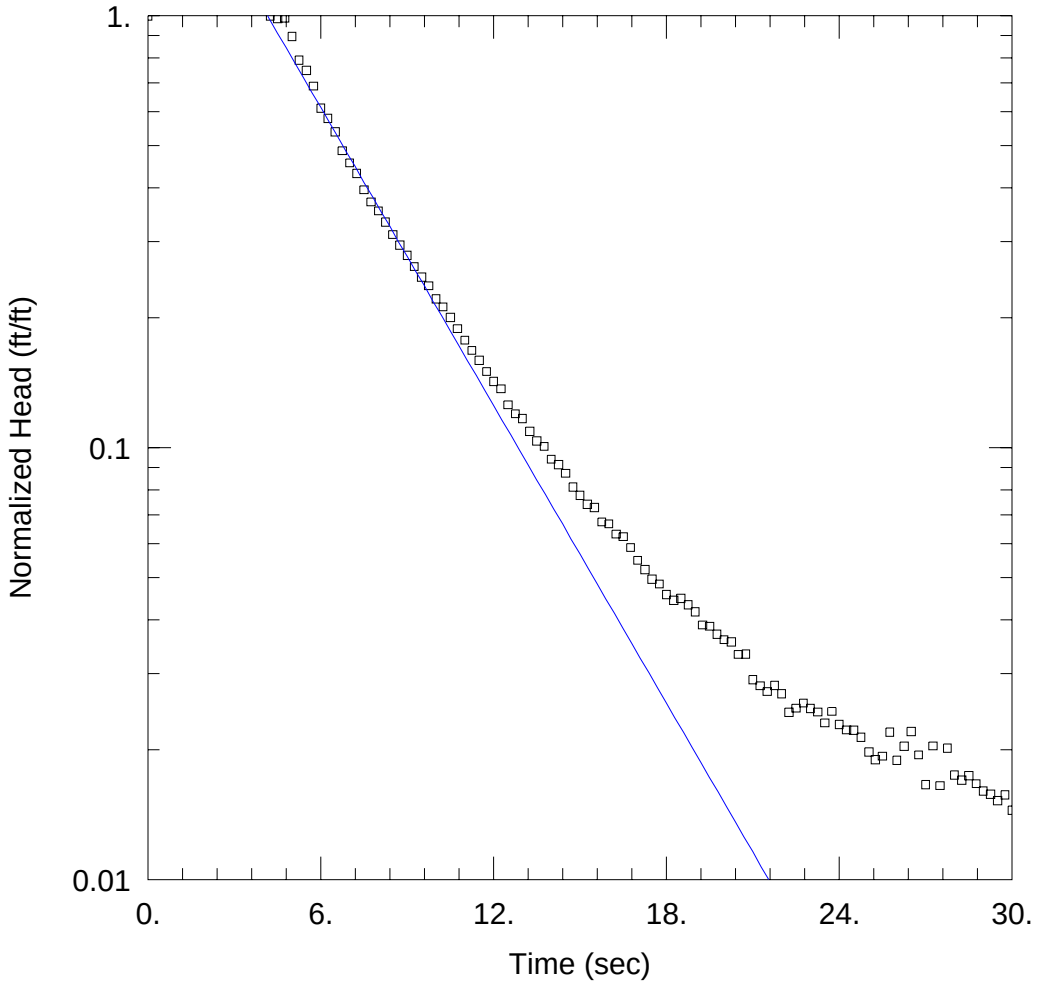
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 24.35 ft/day
Kz/Kr = 1.
Ss = 1.0E-12 ft^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt
Date: 05/24/18 Time: 12:10:36

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

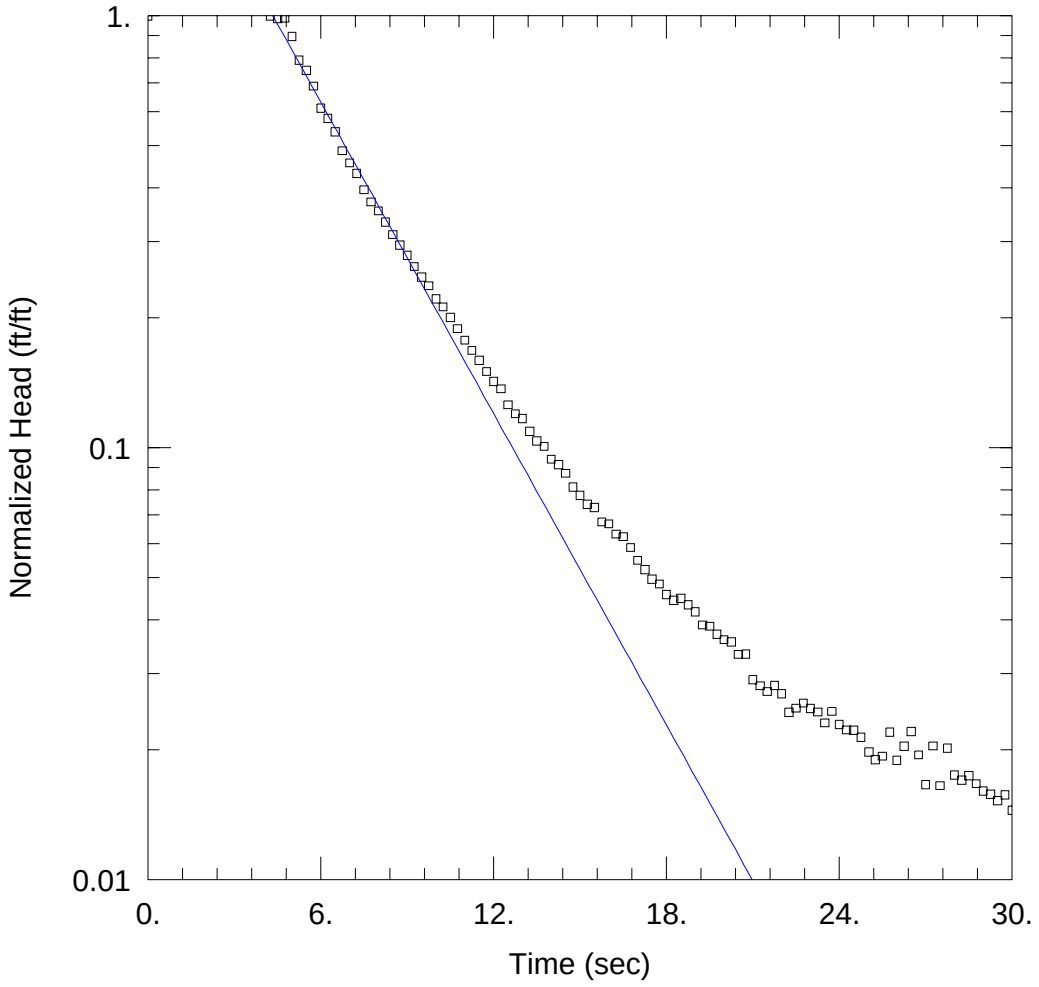
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 29.62 ft/day
y0 = 3.005 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt
Date: 05/24/18 Time: 12:11:05

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

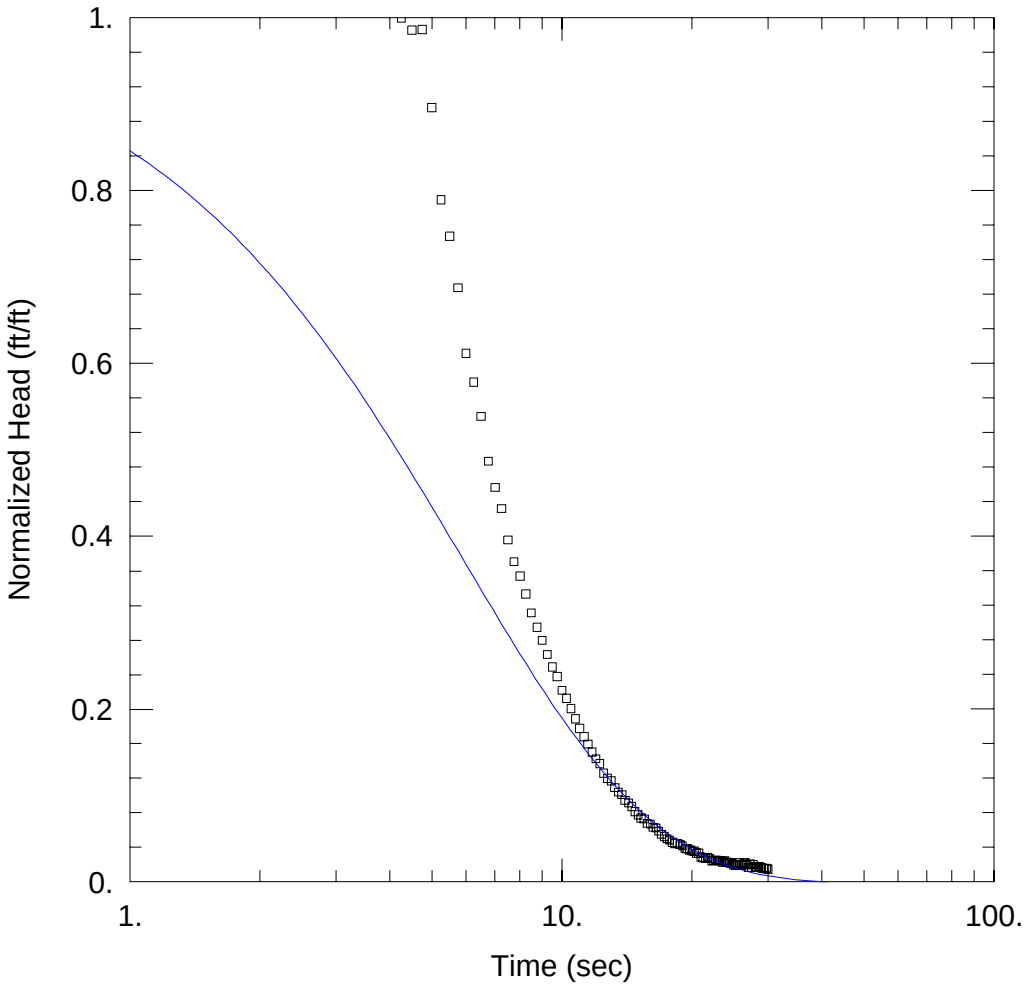
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Static Water Column Height: 31.61 ft
Total Well Penetration Depth: 31.61 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 39.46 ft/day
y0 = 3.33 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt
Date: 05/24/18 Time: 12:09:50

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

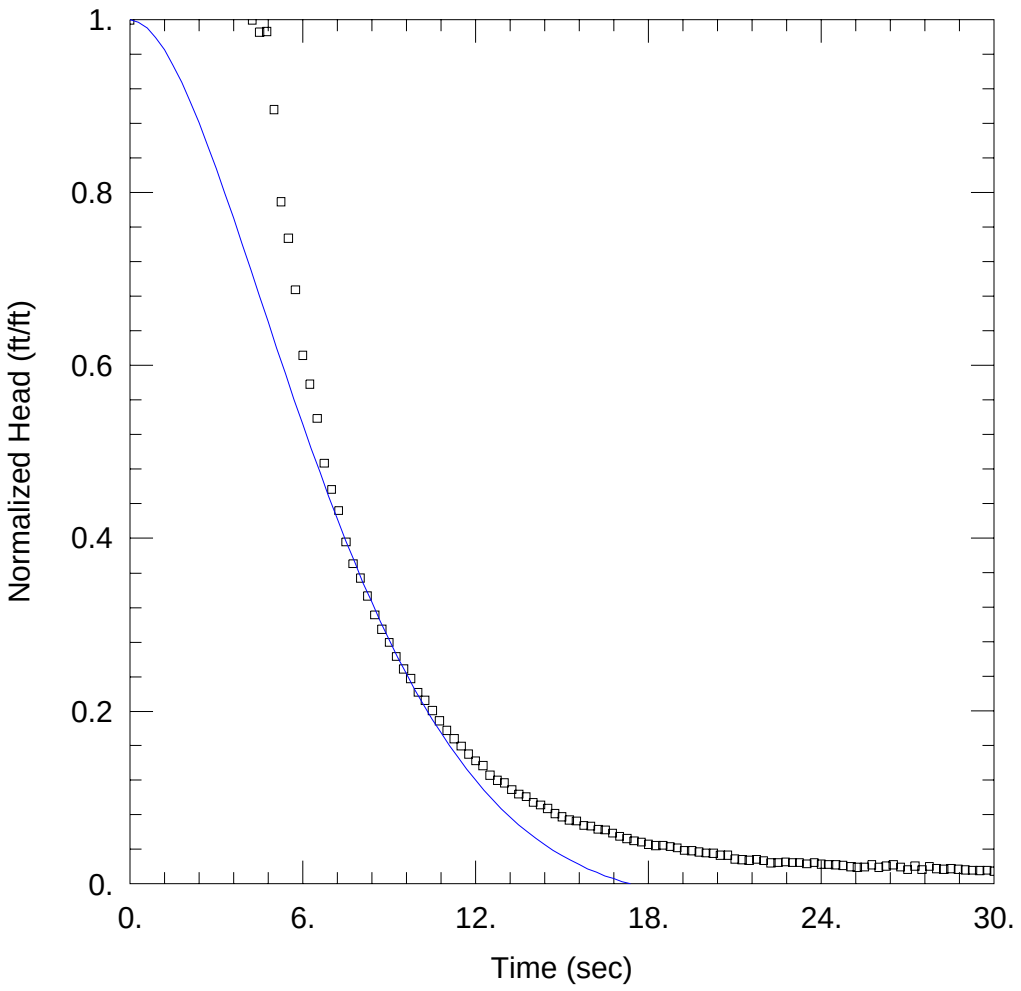
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 21.81 ft/day
Kz/Kr = 1.
Ss = 1.0E-12 ft^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run2 normalized.aqt
Date: 05/24/18 Time: 12:09:20

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

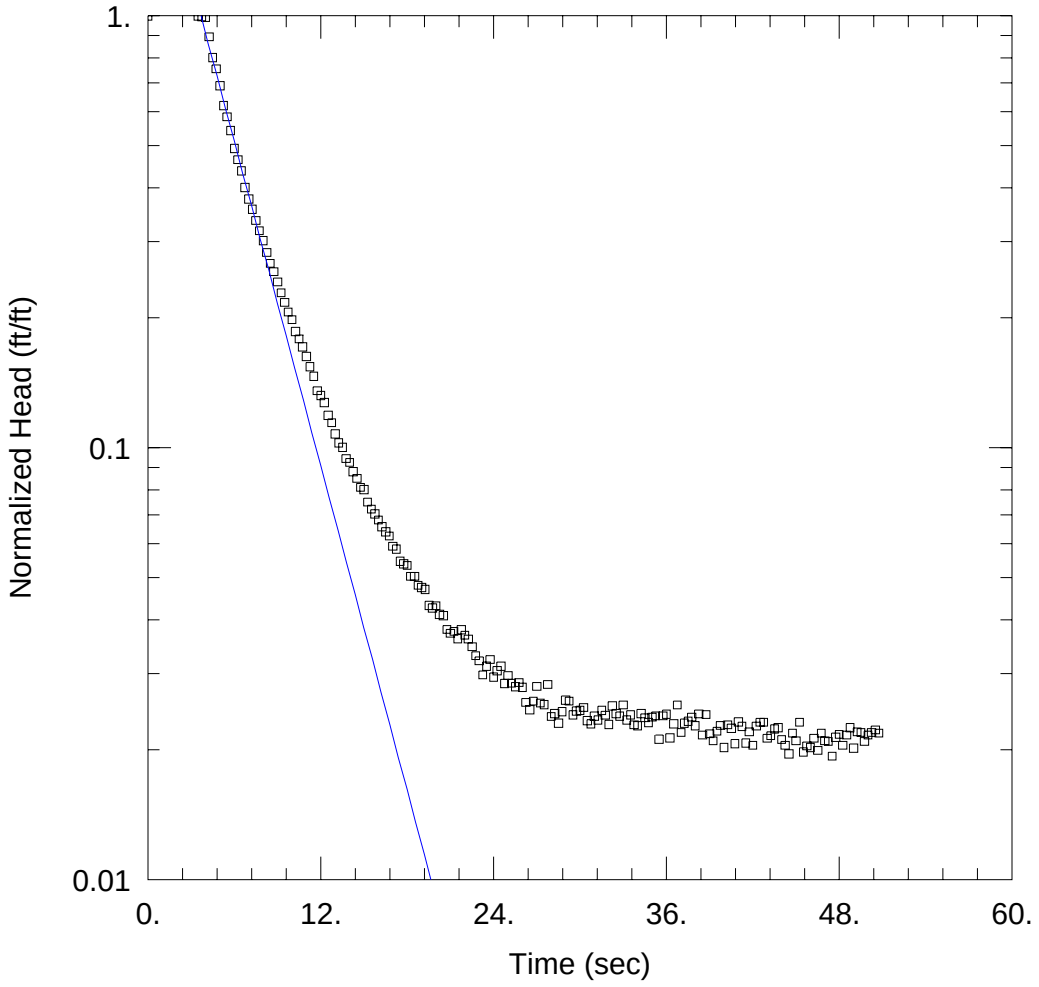
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Static Water Column Height: 31.61 ft
Total Well Penetration Depth: 31.61 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 16.65 ft/day
Le = 573.9 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt
Date: 05/24/18 Time: 12:12:07

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

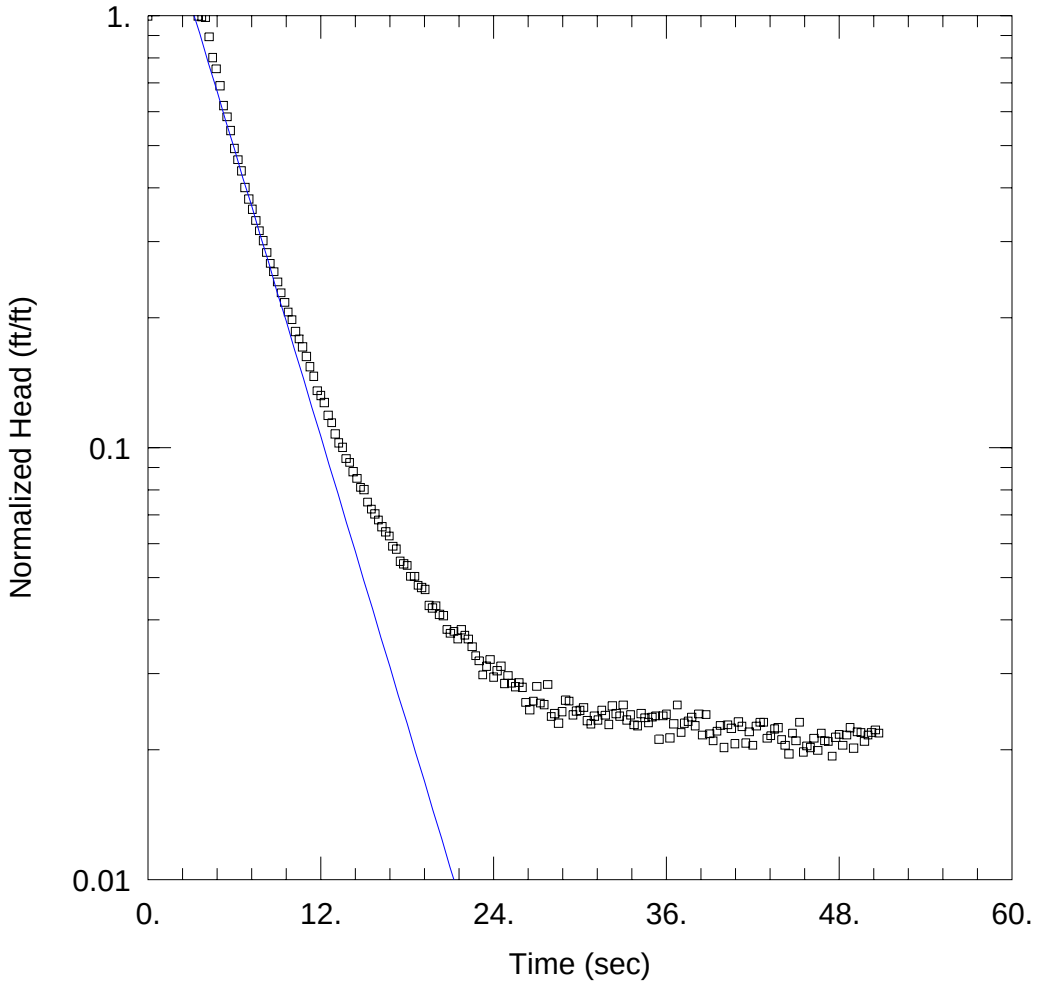
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 32.26 ft/day
y0 = 2.894 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt
Date: 05/24/18 Time: 12:12:34

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

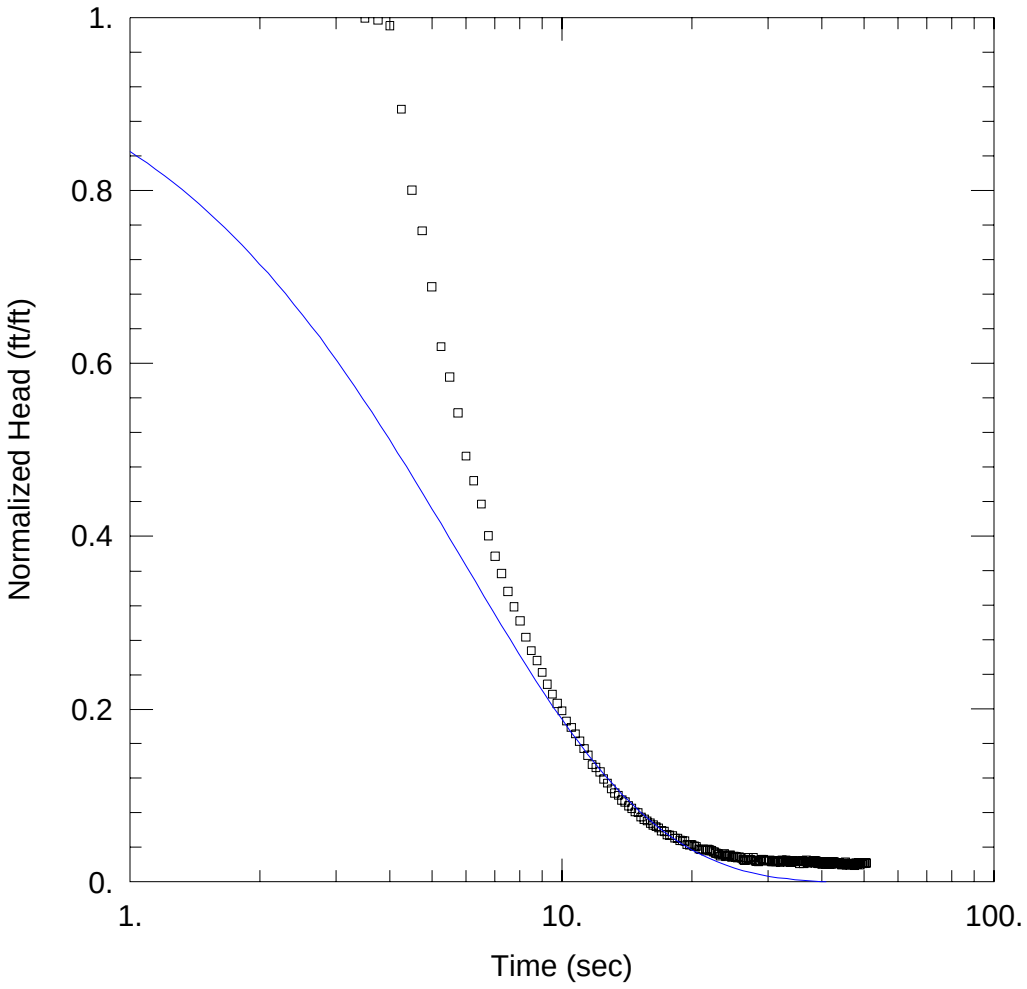
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 36.44 ft/day y0 = 2.284 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt
Date: 05/24/18 Time: 12:11:44

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft

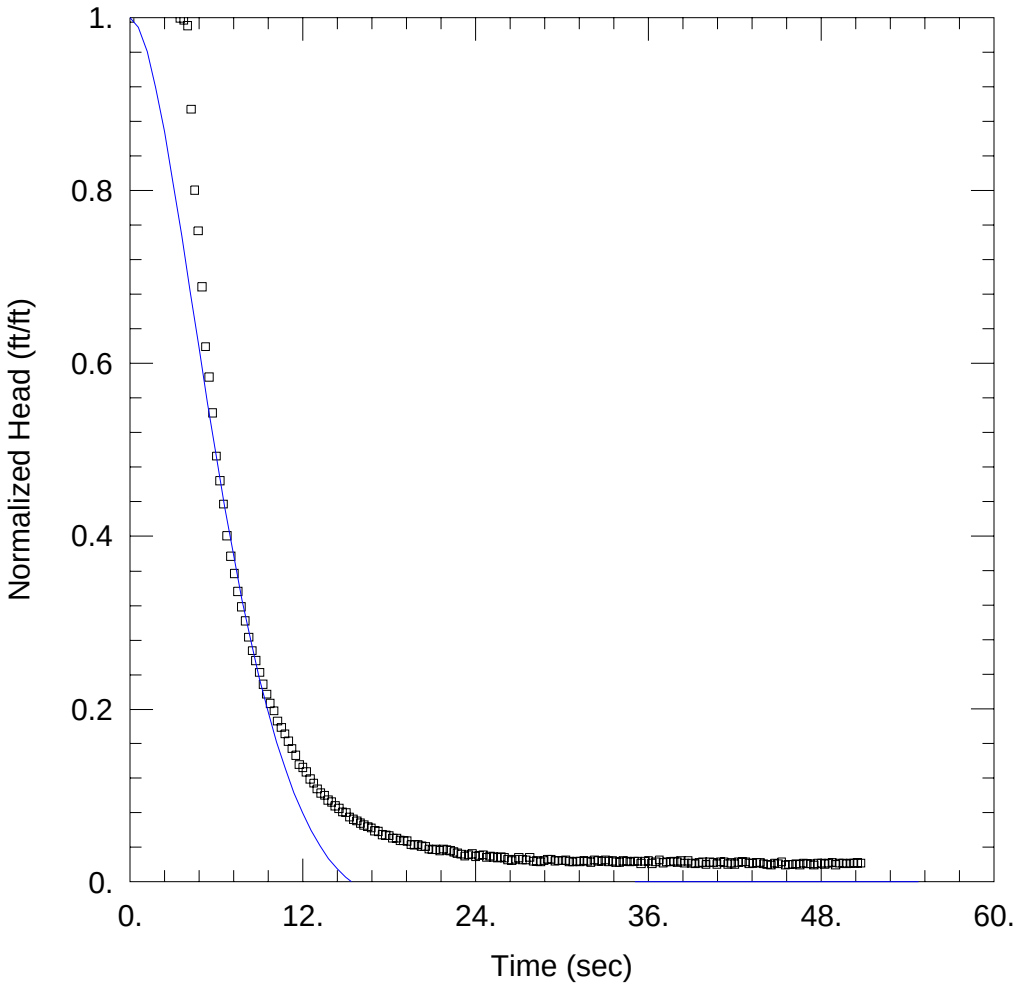
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 31.61 ft
Casing Radius: 0.083 ft
Static Water Column Height: 31.61 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 21.92 ft/day
Kz/Kr = 1.
Ss = 1.0E-12 ft^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-15S Run3 normalized.aqt
Date: 05/24/18 Time: 12:11:23

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-15S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

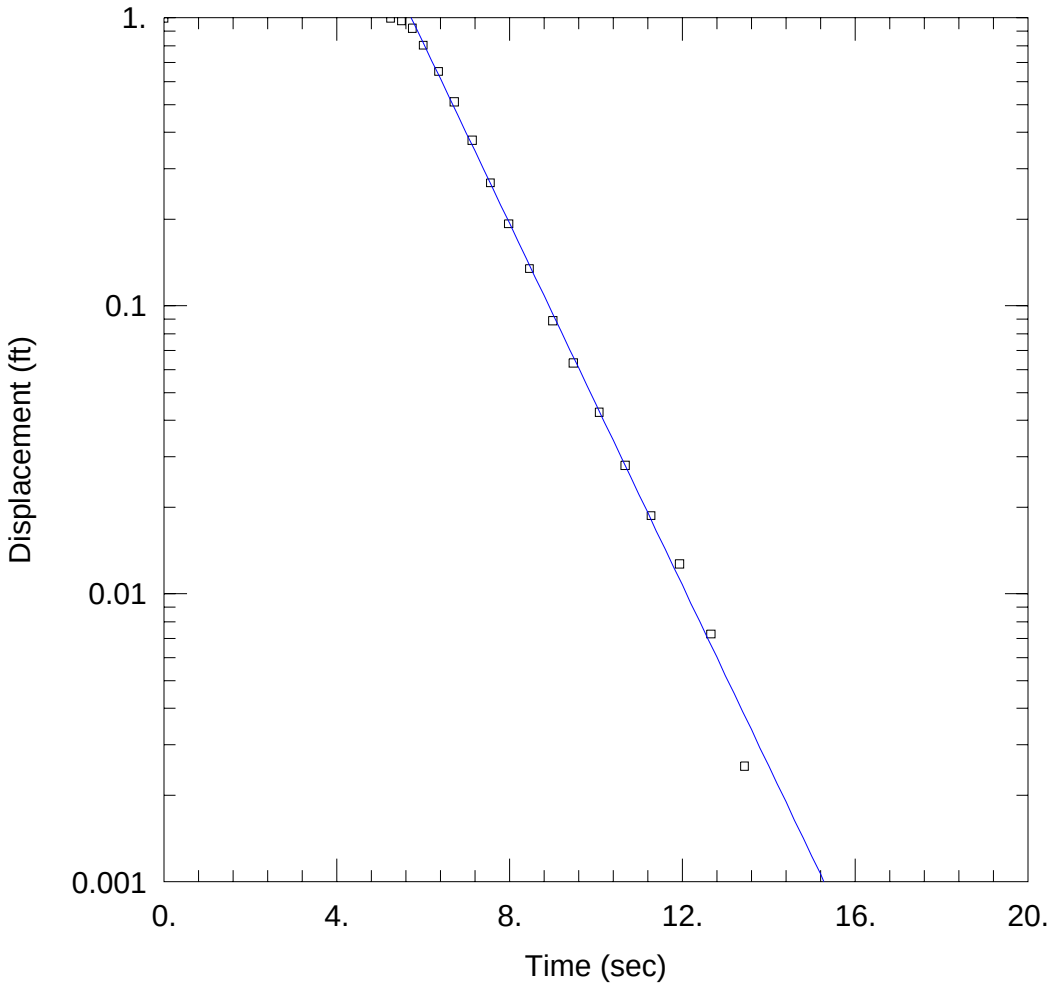
WELL DATA (MW-15S)

Initial Displacement: 1. ft
Static Water Column Height: 31.61 ft
Total Well Penetration Depth: 31.61 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 18.17 ft/day
Le = 514.8 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run1 normalized.aqt
Date: 05/24/18 Time: 12:13:51

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

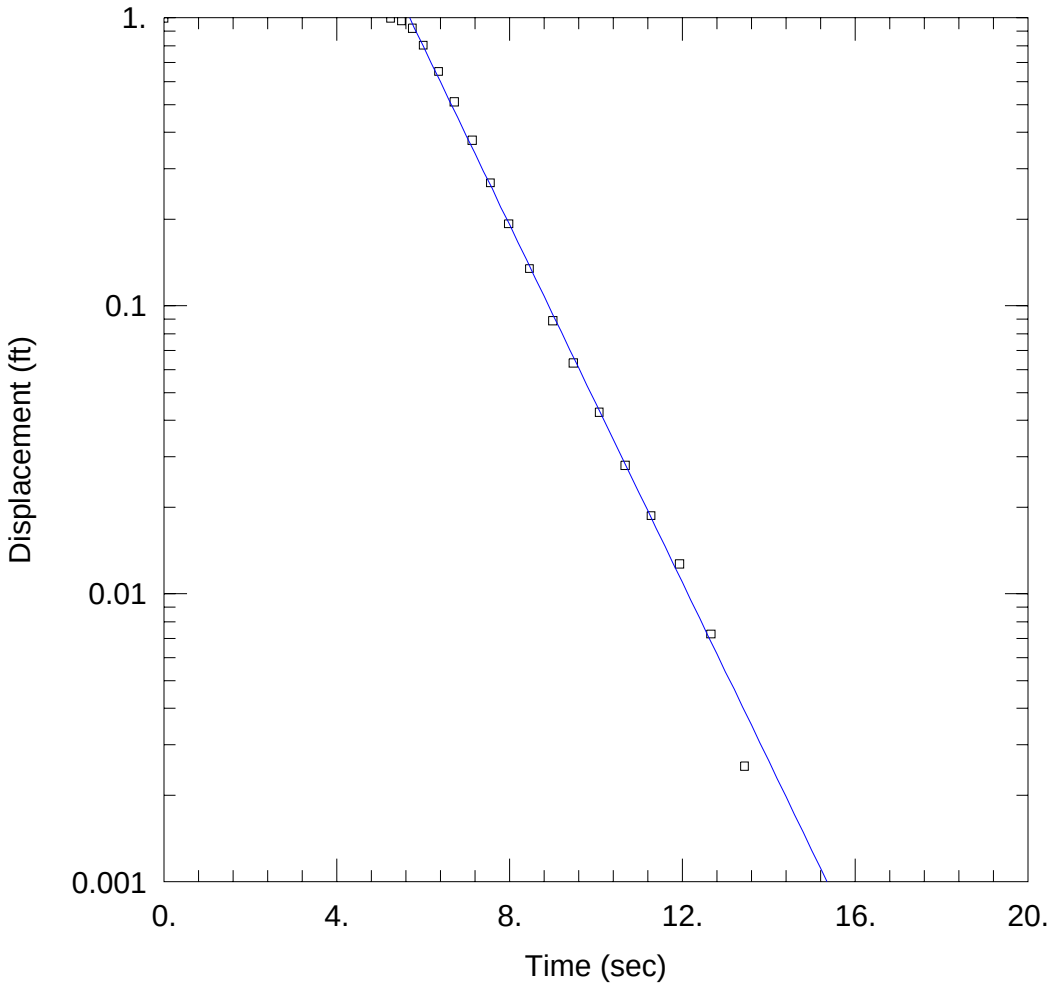
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 32.32 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.32 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 81.16 ft/day
y0 = 62.95 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run1 normalized.aqt
Date: 05/24/18 Time: 12:14:16

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

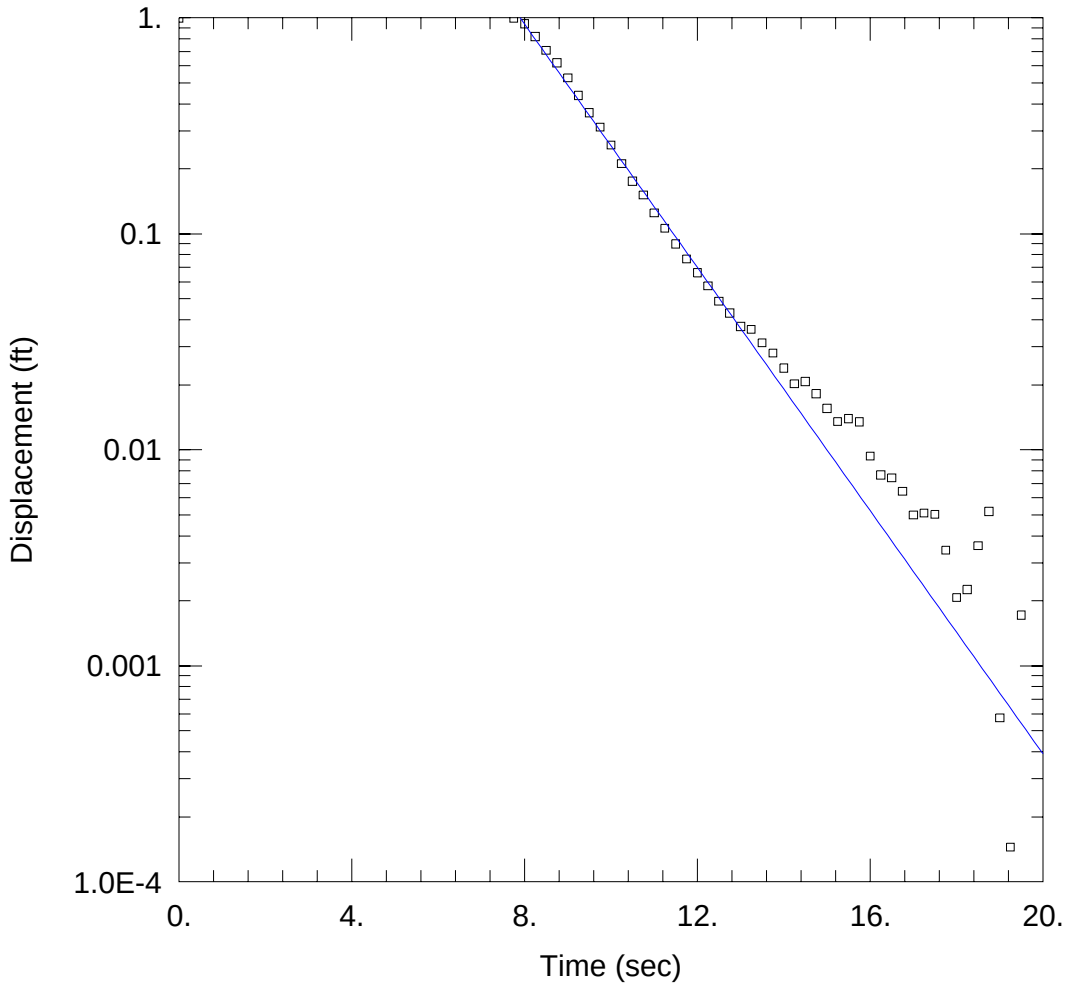
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft
Static Water Column Height: 32.32 ft
Total Well Penetration Depth: 32.32 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 101.9 ft/day
y0 = 58.22 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run2 normalized.aqt
Date: 05/24/18 Time: 12:15:30

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

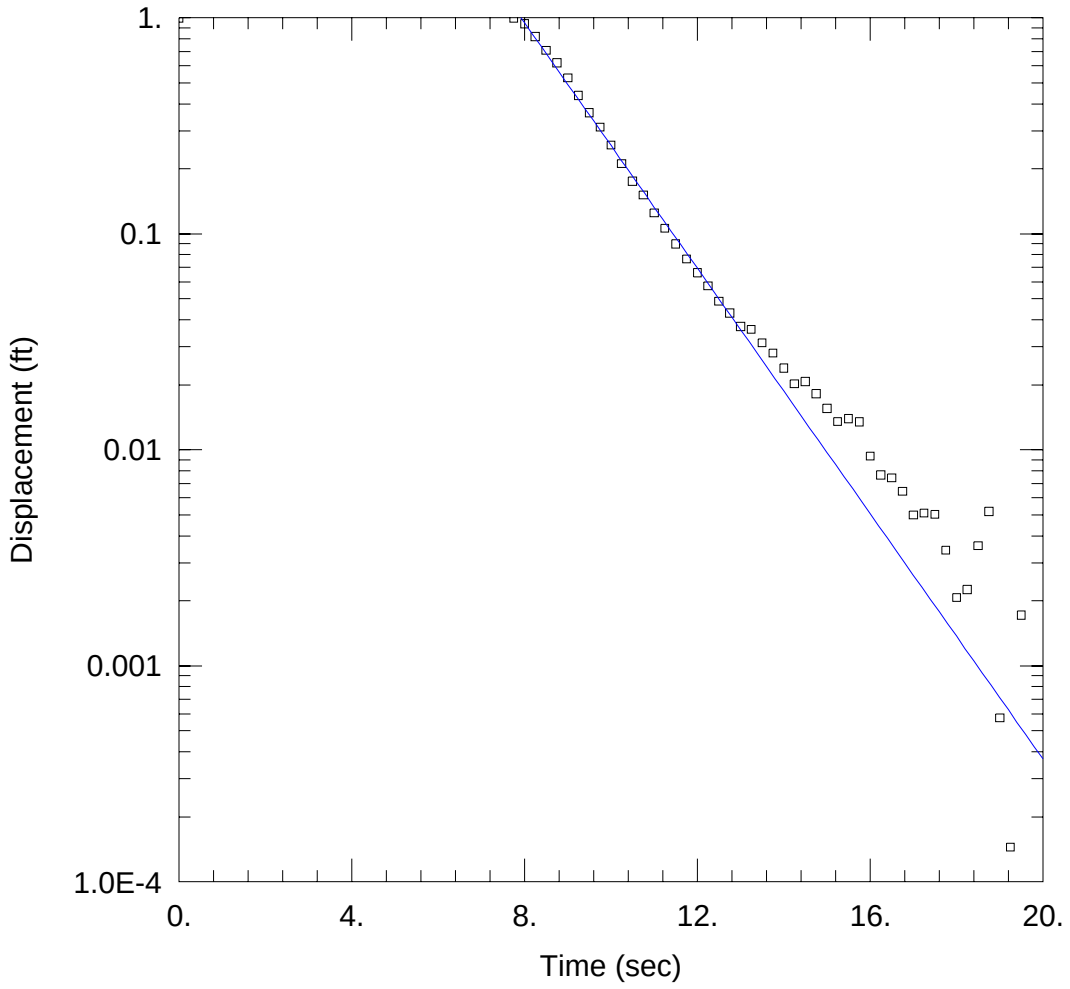
WELL DATA (MW-16S)

Initial Displacement: 1. ft
Static Water Column Height: 32.32 ft
Total Well Penetration Depth: 32.32 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 72.77 ft/day
y0 = 167.2 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run2 normalized.aqt
Date: 05/24/18 Time: 12:15:03

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

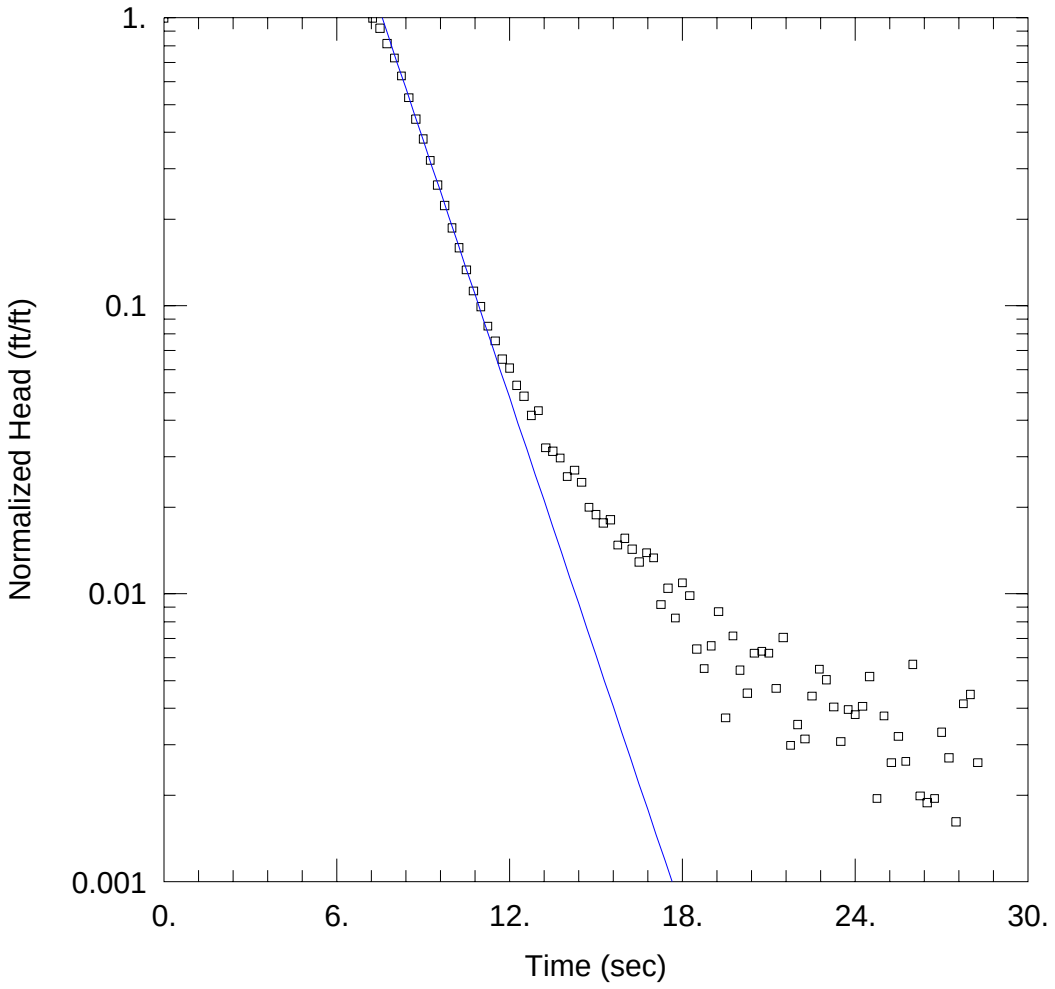
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft
Static Water Column Height: 32.32 ft
Total Well Penetration Depth: 32.32 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 93.27 ft/day
y0 = 177.9 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run3 normalized.aqt
Date: 05/24/18 Time: 12:16:11

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

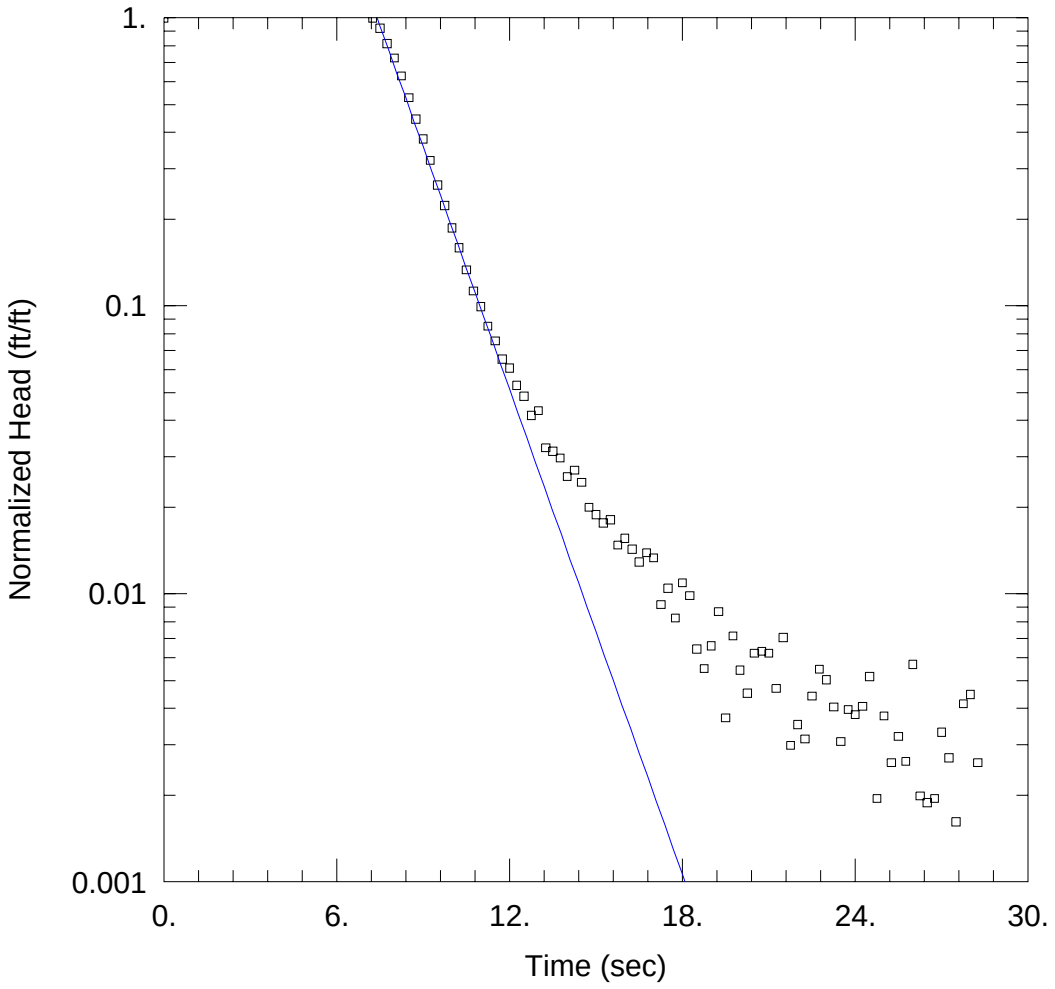
Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 32.32 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.32 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 77.05 ft/day
y0 = 181.8 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-16S Run3 normalized.aqt
Date: 05/24/18 Time: 12:16:30

PROJECT INFORMATION

Company: AECOM
Client: Town of Orleans
Project: 60476644
Location: Orleans, MA
Test Well: MW-16S
Test Date: 3/1/18

AQUIFER DATA

Saturated Thickness: 100. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-16S)

Initial Displacement: 1. ft
Total Well Penetration Depth: 32.32 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.32 ft
Screen Length: 10. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 92.15 ft/day
y0 = 120. ft

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Appendix K

Laboratory Reports – Groundwater Quality

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CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1702113

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 5:08 pm, Feb 15, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

SAMPLE RECEIPT

The following samples were received on February 06, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1702113-01	MW-2S (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-02	MW-2D (124-134)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-03	MW-2D (124-134) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-04	MW-5S (78-88)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702113-05	MW-5D (124-134)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702113-06	MW-6A (64-74)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-07	MW-6B (54-64)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-08	MW-6 (88-98)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-09	MW-7S (55-65)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-10	MW-7D (115-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-11	MW-2 (140-150)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702113-12	MW-7S (55-65) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

PROJECT NARRATIVE

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution
C7B0084-TUN1 **DDT breakdown > 20%**

No other observations noted.

End of Project Narrative.

DATA USABILITY LINKS

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 02/06/17 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/07/17 22:29	10	10	CB70703
Manganese	**0.545** (0.020)		200.7		1	KJK	02/07/17 22:29	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 02/06/17 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.281** (0.050)		200.7		1	KJK	02/07/17 20:34	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 02/06/17 14:55
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-01
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 1:40	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	54 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 02/06/17 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.14** (0.10)		350.1		1	JLK	02/08/17 18:37	mg/L	CB70721
Chloride	**88.8** (3.0)		9250		1	JLK	02/10/17 16:03	mg/L	CB71038
Dissolved Organic Carbon (Average)	**9.49** (0.500)		5310B		1	DEL	02/07/17 18:47	mg/L	[CALC]
Nitrate as N	**18.8** (1.01)		353.2		50	JLK	02/07/17 19:53	mg/L	[CALC]
Nitrite as N	**0.041** (0.010)		353.2		1	JLK	02/07/17 17:26	mg/L	CB70728
Sulfate	**77.0** (50.0)		9038		10	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**2.13** (0.20)		351.2		1	EEM	02/08/17 15:12	mg/L	CB70707
Total Nitrogen	**21.0** (1.20)		4500N		50	EEM	02/08/17 15:12	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 02/06/17 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/07/17 22:33	10	10	CB70703
Manganese	**5.12** (0.020)		200.7		1	KJK	02/07/17 22:33	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 02/06/17 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.259** (0.050)		200.7		1	KJK	02/07/17 20:39	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 02/06/17 14:20
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-02
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	**1.84** (0.250)		8270D SIM		1	02/08/17 2:16	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	64 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 02/06/17 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.5** (1.00)		350.1		10	JLK	02/08/17 18:51	mg/L	CB70721
Chloride	**97.7** (3.0)		9250		1	JLK	02/10/17 16:05	mg/L	CB71038
Dissolved Organic Carbon (Average)	**7.20** (0.500)		5310B		1	DEL	02/07/17 19:51	mg/L	[CALC]
Nitrate as N	**0.208** (0.030)		353.2		1	JLK	02/07/17 19:54	mg/L	[CALC]
Nitrite as N	**0.014** (0.010)		353.2		1	JLK	02/07/17 17:02	mg/L	CB70728
Sulfate	**52.5** (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**13.7** (1.00)		351.2		5	EEM	02/08/17 16:38	mg/L	CB70707
Total Nitrogen	**13.9** (1.02)		4500N		5	EEM	02/08/17 16:38	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134) DUP
Date Sampled: 02/06/17 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.113** (0.100)		200.7		1	KJK	02/07/17 22:37	10	10	CB70703
Manganese	**5.10** (0.020)		200.7		1	KJK	02/07/17 22:37	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134) DUP
Date Sampled: 02/06/17 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.254** (0.050)		200.7		1	KJK	02/07/17 20:43	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134) DUP
Date Sampled: 02/06/17 14:25
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-03
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	**1.70** (0.250)		8270D SIM		1	02/08/17 2:52	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	67 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134) DUP
Date Sampled: 02/06/17 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.2** (1.00)		350.1		10	JLK	02/08/17 18:55	mg/L	CB70721
Chloride	**99.2** (3.0)		9250		1	JLK	02/10/17 16:06	mg/L	CB71038
Dissolved Organic Carbon (Average)	**8.61** (0.500)		5310B		1	DEL	02/07/17 20:03	mg/L	[CALC]
Nitrate as N	**0.180** (0.030)		353.2		1	JLK	02/07/17 19:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:03	mg/L	CB70728
Sulfate	**52.0** (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**14.7** (1.00)		351.2		5	EEM	02/08/17 16:39	mg/L	CB70707
Total Nitrogen	**14.8** (1.02)		4500N		5	EEM	02/08/17 16:39	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5S (78-88)
Date Sampled: 02/06/17 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.101** (0.100)		200.7		1	KJK	02/07/17 22:41	10	10	CB70703
Manganese	**0.112** (0.020)		200.7		1	KJK	02/07/17 22:41	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5S (78-88)
Date Sampled: 02/06/17 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.108** (0.050)		200.7		1	KJK	02/07/17 20:47	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5S (78-88)
Date Sampled: 02/06/17 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.12** (0.10)		350.1		1	JLK	02/08/17 18:41	mg/L	CB70721
Chloride	**63.5** (3.0)		9250		1	JLK	02/10/17 16:06	mg/L	CB71038
Nitrate as N	**17.3** (1.01)		353.2		50	JLK	02/07/17 19:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:04	mg/L	CB70728
Sulfate	**55.0** (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**2.19** (0.20)		351.2		1	EEM	02/08/17 15:15	mg/L	CB70707
Total Nitrogen	**19.5** (1.20)		4500N		50	EEM	02/08/17 15:15	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5D (124-134)
Date Sampled: 02/06/17 16:30
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.622** (0.100)		200.7		1	KJK	02/07/17 22:58	10	10	CB70703
Manganese	**0.524** (0.020)		200.7		1	KJK	02/07/17 22:58	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5D (124-134)
Date Sampled: 02/06/17 16:30
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.056** (0.050)		200.7		1	KJK	02/07/17 21:04	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5D (124-134)
Date Sampled: 02/06/17 16:30
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**12.7** (1.00)		350.1		10	JLK	02/08/17 18:56	mg/L	CB70721
Chloride	**66.1** (3.0)		9250		1	JLK	02/10/17 16:07	mg/L	CB71038
Nitrate as N	**0.046** (0.030)		353.2		1	JLK	02/07/17 20:02	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:06	mg/L	CB70728
Sulfate	**24.0** (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**13.9** (1.00)		351.2		5	EEM	02/08/17 16:40	mg/L	CB70707
Total Nitrogen	**13.9** (1.02)		4500N		5	EEM	02/08/17 16:40	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 02/06/17 12:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.147** (0.100)		200.7		1	KJK	02/07/17 23:02	10	10	CB70703
Manganese	**0.053** (0.020)		200.7		1	KJK	02/07/17 23:02	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 02/06/17 12:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.100** (0.050)		200.7		1	KJK	02/07/17 21:08	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 02/06/17 12:15
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-06
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 3:28	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	65 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 02/06/17 12:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	02/08/17 18:44	mg/L	CB70721
Chloride	**280** (15.0)		9250		5	JLK	02/10/17 16:17	mg/L	CB71038
Dissolved Organic Carbon (Average)	**8.07** (0.500)		5310B		1	DEL	02/07/17 20:16	mg/L	[CALC]
Nitrate as N	**7.20** (0.210)		353.2		10	JLK	02/07/17 20:03	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:07	mg/L	CB70728
Sulfate	**34.4** (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**1.70** (0.20)		351.2		1	EEM	02/08/17 15:17	mg/L	CB70707
Total Nitrogen	**8.90** (0.40)		4500N		10	EEM	02/08/17 15:17	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 02/06/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.158** (0.100)		200.7		1	KJK	02/07/17 23:06	10	10	CB70703
Manganese	**0.038** (0.020)		200.7		1	KJK	02/07/17 23:06	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 02/06/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.109** (0.050)		200.7		1	KJK	02/07/17 21:12	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 02/06/17 11:40
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-07
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 4:05	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	67 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 02/06/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.11** (0.10)		350.1		1	EEM	02/15/17 15:31	mg/L	CB71417
Chloride	**151** (6.0)		9250		2	JLK	02/10/17 16:18	mg/L	CB71038
Dissolved Organic Carbon (Average)	**6.68** (0.500)		5310B		1	DEL	02/07/17 20:53	mg/L	[CALC]
Nitrate as N	**16.3** (1.01)		353.2		50	JLK	02/07/17 20:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:08	mg/L	CB70728
Sulfate	**41.5** (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**1.50** (0.20)		351.2		1	EEM	02/08/17 15:17	mg/L	CB70707
Total Nitrogen	**17.8** (1.20)		4500N		50	EEM	02/08/17 15:17	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 02/06/17 11:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**18.4** (0.100)		200.7		1	KJK	02/07/17 23:10	10	10	CB70703
Manganese	**2.49** (0.020)		200.7		1	KJK	02/07/17 23:10	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 02/06/17 11:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.241** (0.050)		200.7		1	KJK	02/07/17 21:16	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 02/06/17 11:10
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-08
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 18:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	**0.687** (0.250)		8270D SIM		1	02/08/17 4:40	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	35 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 02/06/17 11:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.12** (0.10)		350.1		1	JLK	02/08/17 18:45	mg/L	CB70721
Chloride	**173** (6.0)		9250		2	JLK	02/10/17 16:18	mg/L	CB71038
Dissolved Organic Carbon (Average)	**8.75** (0.500)		5310B		1	DEL	02/07/17 21:05	mg/L	[CALC]
Nitrate as N	**0.051** (0.030)		353.2		1	JLK	02/07/17 20:05	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:09	mg/L	CB70728
Sulfate	**22.5** (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**24.1** (2.00)		351.2		10	EEM	02/08/17 16:41	mg/L	CB70707
Total Nitrogen	**24.2** (2.02)		4500N		10	EEM	02/08/17 16:41	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 02/06/17 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.342** (0.100)		200.7		1	KJK	02/07/17 23:14	10	10	CB70703
Manganese	**0.024** (0.020)		200.7		1	KJK	02/07/17 23:14	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 02/06/17 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.078** (0.050)		200.7		1	KJK	02/07/17 21:20	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 02/06/17 10:10
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-09
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 5:16	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	56 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 02/06/17 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.34** (0.10)		350.1		1	JLK	02/08/17 18:46	mg/L	CB70721
Chloride	**127** (6.0)		9250		2	JLK	02/10/17 16:19	mg/L	CB71038
Dissolved Organic Carbon (Average)	**16.0** (0.500)		5310B		1	DEL	02/07/17 21:18	mg/L	[CALC]
Nitrate as N	**8.68** (0.210)		353.2		10	JLK	02/07/17 19:46	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:10	mg/L	CB70728
Sulfate	**29.6** (5.0)		9038		1	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**1.92** (0.20)		351.2		1	EEM	02/08/17 15:25	mg/L	CB70707
Total Nitrogen	**10.6** (0.40)		4500N		10	EEM	02/08/17 15:25	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 02/06/17 09:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**18.3** (0.100)		200.7		1	KJK	02/07/17 23:19	10	10	CB70703
Manganese	**3.21** (0.020)		200.7		1	KJK	02/07/17 23:19	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 02/06/17 09:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.138** (0.050)		200.7		1	KJK	02/07/17 21:24	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 02/06/17 09:40
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-10
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	**1.70** (0.250)		8270D SIM		1	02/08/17 5:52	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	43 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 02/06/17 09:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**2.74** (0.10)		350.1		1	JLK	02/08/17 18:47	mg/L	CB70721
Chloride	**55.3** (3.0)		9250		1	JLK	02/10/17 16:11	mg/L	CB71038
Dissolved Organic Carbon (Average)	**5.83** (0.500)		5310B		1	DEL	02/07/17 21:30	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	02/07/17 19:47	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:13	mg/L	CB70728
Sulfate	**36.2** (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**3.17** (0.20)		351.2		1	EEM	02/08/17 15:26	mg/L	CB70707
Total Nitrogen	**3.17** (0.22)		4500N		1	EEM	02/08/17 15:26	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 02/06/17 10:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	02/07/17 23:23	10	10	CB70703
Manganese	**5.46** (0.020)		200.7		1	KJK	02/07/17 23:23	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 02/06/17 10:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.281** (0.050)		200.7		1	KJK	02/07/17 21:29	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 02/06/17 10:15
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-11
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	**2.05** (0.250)		8270D SIM		1	02/08/17 6:27	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	49 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 02/06/17 10:15
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.9** (1.00)		350.1		10	JLK	02/08/17 18:57	mg/L	CB70721
Chloride	**49.0** (3.0)		9250		1	JLK	02/10/17 16:12	mg/L	CB71038
Dissolved Organic Carbon (Average)	**6.95** (0.500)		5310B		1	DEL	02/07/17 21:43	mg/L	[CALC]
Nitrate as N	ND (0.030)		353.2		1	JLK	02/07/17 19:48	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:14	mg/L	CB70728
Sulfate	**62.0** (25.0)		9038		5	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**12.8** (1.00)		351.2		5	EEM	02/08/17 16:42	mg/L	CB70707
Total Nitrogen	**12.8** (1.02)		4500N		5	EEM	02/08/17 16:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65) DUP
Date Sampled: 02/06/17 13:45
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-12
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.271** (0.100)		200.7		1	KJK	02/07/17 23:27	10	10	CB70703
Manganese	**0.024** (0.020)		200.7		1	KJK	02/07/17 23:27	10	10	CB70703

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65) DUP
Date Sampled: 02/06/17 13:45
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-12
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.084** (0.050)		200.7		1	KJK	02/07/17 21:33	50	25	CB70701

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65) DUP
Date Sampled: 02/06/17 13:45
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-12
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/7/17 19:00

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/08/17 7:03	C7B0106	CB70742

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	48 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65) DUP
Date Sampled: 02/06/17 13:45
Percent Solids: N/A

ESS Laboratory Work Order: 1702113
ESS Laboratory Sample ID: 1702113-12
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.13** (0.10)		350.1		1	JLK	02/08/17 18:49	mg/L	CB70721
Chloride	**124** (6.0)		9250		2	JLK	02/10/17 16:19	mg/L	CB71038
Dissolved Organic Carbon (Average)	**14.1** (0.500)		5310B		1	DEL	02/08/17 17:11	mg/L	[CALC]
Nitrate as N	**12.8** (1.01)		353.2		50	JLK	02/07/17 20:12	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/07/17 17:15	mg/L	CB70728
Sulfate	**33.6** (10.0)		9038		2	EEM	02/07/17 17:25	mg/L	CB70718
Total Kjeldahl Nitrogen as N	**2.38** (0.20)		351.2		1	EEM	02/08/17 15:27	mg/L	CB70707
Total Nitrogen	**15.2** (1.20)		4500N		50	EEM	02/08/17 15:27	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CB70703 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.44		mg/L	2.500		98	80-120			
Manganese	0.490		mg/L	0.5000		98	80-120			
Total Metals										
Batch CB70701 - 3005A										
Blank										
Boron	ND	0.050	mg/L							
LCS										
Boron	0.241	0.050	mg/L	0.2500		96	85-115			
8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution										
Batch CB70742 - 3535A										
Blank										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	*3.71*		ug/L	*5.000*		*74*	*15-115*			
LCS										
1,4-Dioxane	10.8	0.250	ug/L	10.00		108	40-140			
Surrogate: 1,4-Dioxane-d8	*3.37*		ug/L	*5.000*		*67*	*15-115*			
LCS Dup										
1,4-Dioxane	10.5	0.250	ug/L	10.00		105	40-140	3	20	
Surrogate: 1,4-Dioxane-d8	*3.39*		ug/L	*5.000*		*68*	*15-115*			
Classical Chemistry										
Batch CB70707 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	18.9	2.00	mg/L	18.80		101	80-120			
Total Kjeldahl Nitrogen as N	18.9	2.00	mg/L	18.80		101	80-120			
Total Nitrogen	18.9	2.00	mg/L							
Batch CB70718 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.6		mg/L	9.988		96	85-115			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CB70721 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		100	80-120			
LCS										
Ammonia as N	1.04	0.10	mg/L	0.9994		104	80-120			
Batch CB70728 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.248		mg/L	0.2497		100	90-110			
Nitrite as N	0.248		mg/L	0.2497		100	90-110			
Batch CB70729 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.462		mg/L							
Nitrate/Nitrite as N	0.462		mg/L	0.5000		92	90-110			
Nitrate/Nitrite as N	0.462		mg/L	0.5000		92	90-110			
Total Nitrogen	0.462		mg/L							
Batch CB70741 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.47	0.500	mg/L	5.000		89	80-120			
Dissolved Organic Carbon (2)	4.55	0.500	mg/L	5.000		91	80-120			
Dissolved Organic Carbon (Average)	4.51	0.500	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	4.55	0.500	mg/L	5.000		91	80-120	2	200	
Dissolved Organic Carbon (2)	4.60	0.500	mg/L	5.000		92	80-120	1	200	
Dissolved Organic Carbon (Average)	4.57	0.500	mg/L							
Batch CB71038 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CB71038 - General Preparation										
LCS										
Chloride	30.4		mg/L	30.00		101	90-110			
Batch CB71417 - General Preparation										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
LCS										
Ammonia as N	0.95	0.10	mg/L	0.9994		95	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

Notes and Definitions

U	Analyte included in the analysis, but not detected
DDT	DDT breakdown > 20%
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702113

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1702113
Date Received: 2/6/2017
Project Due Date: 2/13/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? (Yes) / No
    a. Air bubbles in aqueous VOAs? Yes / (No)
    b. Does methanol cover soil completely? Yes / No / (NA)

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	102849	Yes	No	Yes	VOA Vial - HCl	HCl	
01	102850	Yes	No	Yes	VOA Vial - HCl	HCl	
01	102877	Yes	NA	Yes	1L Amber - Unpres	NP	
01	102878	Yes	NA	Yes	1L Amber - Unpres	NP	
01	102888	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
01	102898	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	102908	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	102918	Yes	NA	Yes	250 mL Amber - Unpres	NP	
01	102928	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	102847	Yes	No	Yes	VOA Vial - HCl	HCl	
02	102848	Yes	No	Yes	VOA Vial - HCl	HCl	
02	102875	Yes	NA	Yes	1L Amber - Unpres	NP	
02	102876	Yes	NA	Yes	1L Amber - Unpres	NP	
02	102887	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
02	102897	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	102907	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	102917	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	102927	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	102845	Yes	No	Yes	VOA Vial - HCl	HCl	
03	102846	Yes	No	Yes	VOA Vial - HCl	HCl	
03	102873	Yes	NA	Yes	1L Amber - Unpres	NP	
03	102874	Yes	NA	Yes	1L Amber - Unpres	NP	
03	102886	Yes	NA	Yes	250 mL Poly - HNO3	HNO3	
03	102896	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1702113

Date Received: 2/6/2017

03	102906	Yes	NA	Yes	500 mL Poly - Unpres	NP
03	102916	Yes	NA	Yes	250 mL Amber - Unpres	NP
03	102926	Yes	NA	Yes	250 mL Poly - Unpres	NP
04	102852	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
04	102854	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
04	102856	Yes	NA	Yes	500 mL Poly - Unpres	NP
04	102858	Yes	NA	Yes	250 mL Poly - Unpres	NP
05	102851	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
05	102853	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
05	102855	Yes	NA	Yes	500 mL Poly - Unpres	NP
05	102857	Yes	NA	Yes	250 mL Poly - Unpres	NP
06	102843	Yes	No	Yes	VOA Vial - HCl	HCl
06	102844	Yes	No	Yes	VOA Vial - HCl	HCl
06	102871	Yes	NA	Yes	1L Amber - Unpres	NP
06	102872	Yes	NA	Yes	1L Amber - Unpres	NP
06	102885	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
06	102895	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
06	102905	Yes	NA	Yes	500 mL Poly - Unpres	NP
06	102915	Yes	NA	Yes	250 mL Amber - Unpres	NP
06	102925	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	102841	Yes	No	Yes	VOA Vial - HCl	HCl
07	102842	Yes	No	Yes	VOA Vial - HCl	HCl
07	102869	Yes	NA	Yes	1L Amber - Unpres	NP
07	102870	Yes	NA	Yes	1L Amber - Unpres	NP
07	102884	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
07	102894	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
07	102904	Yes	NA	Yes	500 mL Poly - Unpres	NP
07	102914	Yes	NA	Yes	250 mL Amber - Unpres	NP
07	102924	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	102839	Yes	No	Yes	VOA Vial - HCl	HCl
08	102840	Yes	No	Yes	VOA Vial - HCl	HCl
08	102867	Yes	NA	Yes	1L Amber - Unpres	NP
08	102868	Yes	NA	Yes	1L Amber - Unpres	NP
08	102883	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
08	102893	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
08	102903	Yes	NA	Yes	500 mL Poly - Unpres	NP
08	102913	Yes	NA	Yes	250 mL Amber - Unpres	NP
08	102923	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	102837	Yes	No	Yes	VOA Vial - HCl	HCl
09	102838	Yes	No	Yes	VOA Vial - HCl	HCl
09	102865	Yes	NA	Yes	1L Amber - Unpres	NP
09	102866	Yes	NA	Yes	1L Amber - Unpres	NP
09	102882	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
09	102892	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
09	102902	Yes	NA	Yes	500 mL Poly - Unpres	NP
09	102912	Yes	NA	Yes	250 mL Amber - Unpres	NP
09	102922	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	102835	Yes	No	Yes	VOA Vial - HCl	HCl
10	102836	Yes	No	Yes	VOA Vial - HCl	HCl
10	102863	Yes	NA	Yes	1L Amber - Unpres	NP
10	102864	Yes	NA	Yes	1L Amber - Unpres	NP
10	102881	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
10	102891	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
10	102901	Yes	NA	Yes	500 mL Poly - Unpres	NP
10	102911	Yes	NA	Yes	250 mL Amber - Unpres	NP
10	102921	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	102833	Yes	No	Yes	VOA Vial - HCl	HCl
11	102834	Yes	No	Yes	VOA Vial - HCl	HCl
11	102861	Yes	NA	Yes	1L Amber - Unpres	NP
11	102862	Yes	NA	Yes	1L Amber - Unpres	NP
11	102880	Yes	NA	Yes	250 mL Poly - HNO3	HNO3
11	102890	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
11	102900	Yes	NA	Yes	500 mL Poly - Unpres	NP
11	102910	Yes	NA	Yes	250 mL Amber - Unpres	NP
11	102920	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	102831	Yes	No	Yes	VOA Vial - HCl	HCl
12	102832	Yes	No	Yes	VOA Vial - HCl	HCl
12	102859	Yes	NA	Yes	1L Amber - Unpres	NP
12	102860	Yes	NA	Yes	1L Amber - Unpres	NP
12	102879	Yes	NA	Yes	250 mL Poly - HNO3	HNO3

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1702113
Date Received: 2/6/2017

12	102889	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4
12	102899	Yes	NA	Yes	500 mL Poly - Unpres	NP
12	102909	Yes	NA	Yes	250 mL Amber - Unpres	NP
12	102919	Yes	NA	Yes	250 mL Poly - Unpres	NP

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: _____ Date & Time: 2/6/17 2025

Reviewed By: _____ Date & Time: 2/6/17 2040

Delivered By: _____ 2/6/17 2040

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1702113

Turn Time _____ Standard Other_____

Regulatory State: MA RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM	Project #	Project Name Oneans Landfill	
Contact Person Julianne Marron	Address 250 Apollo Dr		
City Chelmsford	State MA	Zip	PO #
Tel. 781-561-5558	Fax.	email:	

Analysis: NH4, TN; NO2, NO3, SO4, Cl; Dissolved Metals; 1,4 Dioxane; DOC; Boron

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container
1	02/06/17	~~0940~~ 1455	G	GW	MW-2S(84-94)		7		
2	02/06/17	~~1010~~ 1920	G	GW	MW-2D(124-134)		7		
3	02/06/17	~~1015~~ 1425	G	GW	MW-2D(124-134)DUP		7		
4	02/06/17	1615	G	GW	MW-5S(78-88)		4		
5	02/06/17	1630	G	GW	MW-5D(124-134)		4		
6	02/06/17	1215	G	GW	MW-6A(64-74)		7		
7	02/06/17	1140	G	GW	MW-6B(54-64)		7		
8	02/06/17	1110	G	GW	MW-6(88-98)		7		
9	02/06/17	1010	G	GW	MW-7S(55-65)		7		
10	02/06/17	0940	G	GW	MW-7D(115-125)		7		

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

3.3
3.6
3.8
4.1

Cooler Present _____Yes _____No

Seals Intact ____ Yes _____No NA:___

Cooler Temperature: ~~Technician~~ September 9:50 2/6/17

Internal Use Only

[ ] ~~Pickup~~

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by :

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
Brittney Merrill 02/06/17	2/6/17 16:42	2/6/17 19:50	2/6/17 1957
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1702113

Turn Time _____Standard Other_____

Regulatory State: MA RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM	Project #	Project Name	
Contact Person Julianne Marron	Address 250 Apollo Dr		
City Chelmsford	State MA	Zip	PO #
Tel. 781-561-5550	Fax	email:	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: NH_4, TN	NO_2, NO_3, SO4, TN	Dissolved metals	1,4 Dioxane	Doc	Boron
11	01/26/17	1015	G	GW	MW-2(140-180)		7			X	X	X	X	X	X
12	01/26/17	1345	G	GW	MW-7S(55-65)DUP		7			X	X	X	X	X	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

3.3
7.6
3.5
4.1

Cooler Present _____Yes _____No

Seals Intact ____ Yes ____No NA:___

Cooler Temperature: Ice Leaf 11:50 2/6/17

Internal Use Only

[ ] Pickup

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by :

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
Julianne Marron 01/26/17 19:00	2/6/17 19:12	2/6/17 11:50	2/6/17 1957
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1702186

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:43 pm, Feb 16, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

SAMPLE RECEIPT

The following samples were received on February 08, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1702186-01	Stormwater 1	Surface Water	350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702186-02	Stormwater 2	Surface Water	350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: Stormwater 1
Date Sampled: 02/08/17 11:00
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702186
ESS Laboratory Sample ID: 1702186-01
Sample Matrix: Surface Water
Units: ug/L
Analyst: VSC
Prepared: 2/13/17 18:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 0:24	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	58 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: Stormwater 1
Date Sampled: 02/08/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1702186
ESS Laboratory Sample ID: 1702186-01
Sample Matrix: Surface Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.67** (0.10)		350.1		1	JLK	02/13/17 17:27	mg/L	CB71005
Chloride	**455** (30.0)		9250		10	JLK	02/10/17 16:20	mg/L	CB71038
Dissolved Organic Carbon (Average)	**39.6** (5.00)		5310B		10	DEL	02/10/17 18:13	mg/L	[CALC]
Nitrate as N	**0.424** (0.030)		353.2		1	JLK	02/08/17 22:35	mg/L	[CALC]
Nitrite as N	**0.026** (0.010)		353.2		1	JLK	02/08/17 20:43	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**4.05** (0.20)		351.2		1	EEM	02/14/17 16:26	mg/L	CB71332
Total Nitrogen	**4.50** (0.22)		4500N		1	EEM	02/14/17 16:26	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: Stormwater 2
Date Sampled: 02/08/17 10:45
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702186
ESS Laboratory Sample ID: 1702186-02
Sample Matrix: Surface Water
Units: ug/L
Analyst: VSC
Prepared: 2/13/17 18:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 0:58	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	59 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: Stormwater 2
Date Sampled: 02/08/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1702186
ESS Laboratory Sample ID: 1702186-02
Sample Matrix: Surface Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**2.92** (0.10)		350.1		1	JLK	02/13/17 17:43	mg/L	CB71005
Chloride	**188** (15.0)		9250		5	JLK	02/10/17 16:21	mg/L	CB71038
Dissolved Organic Carbon (Average)	**175** (5.00)		5310B		10	DEL	02/10/17 18:51	mg/L	[CALC]
Nitrate as N	**10.5** (1.01)		353.2		50	JLK	02/08/17 23:05	mg/L	[CALC]
Nitrite as N	**0.150** (0.010)		353.2		1	JLK	02/08/17 20:44	mg/L	CB70837
Sulfate	**5.9** (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**16.4** (2.00)		351.2		10	EEM	02/14/17 16:57	mg/L	CB71332
Total Nitrogen	**27.1** (3.00)		4500N		50	EEM	02/14/17 16:57	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution										
Batch CB71341 - 3535A										
Blank										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	*3.11*		ug/L	*5.000*		*62*	*15-115*			
LCS										
1,4-Dioxane	10.9	0.250	ug/L	10.00		109	40-140			
Surrogate: 1,4-Dioxane-d8	*3.41*		ug/L	*5.000*		*68*	*15-115*			
LCS Dup										
1,4-Dioxane	10.7	0.250	ug/L	10.00		107	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	*3.46*		ug/L	*5.000*		*69*	*15-115*			
Classical Chemistry										
Batch CB70837 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.247		mg/L	0.2497		99	90-110			
Nitrite as N	0.247		mg/L	0.2497		99	90-110			
Batch CB70838 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.483		mg/L							
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Total Nitrogen	0.483		mg/L							
Batch CB71005 - General Preparation										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
LCS										
Ammonia as N	1.10	0.10	mg/L	0.9994		110	80-120			
Batch CB71037 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CB71037 - [CALC]										
Dissolved Organic Carbon (Average)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.70	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.86	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.500	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	2	200	
Dissolved Organic Carbon (2)	4.84	0.500	mg/L	5.000		97	80-120	0.3	200	
Dissolved Organic Carbon (Average)	4.82	0.500	mg/L							
Batch CB71038 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	30.4		mg/L	30.00		101	90-110			
Batch CB71323 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.5		mg/L	9.988		95	85-115			
Batch CB71332 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.8	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702186

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1702186
Date Received: 2/8/2017
Project Due Date: 2/15/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? (Yes) / No
    a. Air bubbles in aqueous VOAs? Yes / (No)
    b. Does methanol cover soil completely? Yes / No / (NA)

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

500 ml poly unpres. for sample 1 was rec'd with lid from 500ml poly HNO3 - raised sample pH to 3.
Rec'd 2 bottles for dissolved lab filtered metals for sample 2 not on COC. RL 2/8/17
No collection dates on COC.

14. Was there a need to contact Project Manager? (Yes) / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	103564	Yes	No	Yes	VOA Vial - HCl	HCl	
01	103565	Yes	No	Yes	VOA Vial - HCl	HCl	
01	103568	Yes	NA	Yes	1L Amber - Unpres	NP	
01	103569	Yes	NA	Yes	1L Amber - Unpres	NP	
01	103571	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
01	103573	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	103575	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	103562	Yes	No	Yes	VOA Vial - HCl	HCl	
02	103563	Yes	No	Yes	VOA Vial - HCl	HCl	
02	103566	Yes	NA	Yes	1L Amber - Unpres	NP	
02	103567	Yes	NA	Yes	1L Amber - Unpres	NP	
02	103570	Yes	NA	Yes	500 mL Poly - H2SO4	H2SO4	
02	103572	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	103574	Yes	NA	Yes	250 mL Amber - Unpres	NP	
02	103576	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	103623	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: RL
Reviewed
Date & Time: 2/8/17 1822

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1702186

Date Received: 2/8/2017

By: [signature] Date & Time: 2/8/17 1830

Delivered By: [signature] 2/8/17 1830

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 170186

Turn Time ✓ Standard Other_____

Reporting Limits - MCP

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Electonic Deliverables (Excel) Access (PDF)

Co. Name AECOM	Project # 60476644	Project Name Orleans Landfill Phase I	
Contact Person Julianne Mamon	Address 250 Apollo DR		
City Chelmsford	State MA	Zip 01824	PO # 17915
Tel. 978-905-2419	Fax.	email: Julianne.Mamon@aecom.com	

Analysis: TNH4, TN; NO3, NO3, SO4, Cl, TDS; 1,4 Dioxane; DOC

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	TNH4, TN	NO3, NO3, SO4, Cl, TDS	1,4 Dioxane	DOC
1	02/08/17	11.00	G	SW	Stormwater 1		5			X	X	X	X
2	02/08/17	1045	G	SW	Stormwater 2		5			X	X	X	X
~~3~~	~~02/ /17~~		G	SW	~~Stormwater 3~~		5			X	X	X	X
~~4~~	~~02/ /17~~		G	SW	~~Stormwater 4~~		5			X	X	X	X
~~5~~	~~02/ /17~~		G	SW	~~Stormwater 2DUP~~		5			X	X	X	X
	mkm 2/9/17												

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA: ____

Cooler Temperature: 2.8 2.6 ice 3.1 RB

Internal Use Only
[✓] Pickup
[ ] Technician ____

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-____

Sampled by: J Begley, C Hayden

Comments: SW = stormwater

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
C Hayden 2/8/17 1625	2/8/17 16:25	2/8/17 17:50	2/8/17 1755
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

ESS Laboratory

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Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 170186

Turn Time ✓ Standard Other_____

Reporting Limits - MCP

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Electonic Deliverables (Excel) Access (PDF)

Co. Name AECOM	Project # 60476644	Project Name Orleans Landfill Phase I	
Contact Person Julianne Mamon	Address 250 Apollo DR		
City Chelmsford	State MA	Zip 01824	PO # 17915
Tel. 978-905-2419	Fax.	email: Julianne.Mamon@aecom.com	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: TNH4, TN	NO3, NO2, SO4, Cl, TDS	1,4 Dioxane	DOC
1	02/17	11.00	G	SW	Stormwater 1		5			X	X	X	X
2	02/17	1045	G	SW	Stormwater 2		5			X	X	X	X
~~3~~	~~02/17~~		~~G~~	~~SW~~	~~Stormwater 3~~		~~5~~			~~X~~	~~X~~	~~X~~	~~X~~
~~4~~	~~02/17~~		~~G~~	~~SW~~	~~Stormwater 4~~		~~5~~			~~X~~	~~X~~	~~X~~	~~X~~
~~5~~	~~02/17~~		~~G~~	~~SW~~	~~Stormwater Dup~~		~~5~~			~~X~~	~~X~~	~~X~~	~~X~~

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA:___

Cooler Temperature: 2.8 2.6 ice 3.1 RB

Internal Use Only

[✓] Pickup

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by: J Begley, C Hayden

Comments: SW = stormwater

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
C Hayden 2/8/17 1625	2/8/17 16:25	2/8/17 17:50	2/8/17 1755
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1702187

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:22 pm, Feb 21, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

SAMPLE RECEIPT

The following samples were received on February 08, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1702187-01	MW-1S (56-66)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 8270D SIM, 9038, 9250
1702187-02	MW-1D (99-109)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 8270D SIM, 9038, 9250
1702187-03	MW-3S (50-60)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702187-04	MW-3D (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 9038, 9250
1702187-05	MW-8 (36-46)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702187-06	MW-9 (92-102)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250
1702187-07	MW-10 (85-95)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N, 5310B, 8270D SIM, 9038, 9250

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1S (56-66)
Date Sampled: 02/08/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 14:41	10	10	CB71501
Manganese	**0.369** (0.020)		200.7		1	KJK	02/17/17 14:41	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1S (56-66)
Date Sampled: 02/08/17 11:40
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-01
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/13/17 18:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 1:33	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	68 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1S (56-66)
Date Sampled: 02/08/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	02/13/17 17:44	mg/L	CB71005
Chloride	**13.2** (3.0)		9250		1	JLK	02/10/17 16:41	mg/L	CB71039
Nitrate as N	**3.60** (0.110)		353.2		5	JLK	02/08/17 22:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:45	mg/L	CB70837
Sulfate	**6.7** (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**1.24** (0.20)		351.2		1	EEM	02/14/17 16:33	mg/L	CB71332
Total Nitrogen	**4.84** (0.30)		4500N		5	EEM	02/14/17 16:33	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1D (99-109)
Date Sampled: 02/08/17 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 14:45	10	10	CB71501
Manganese	**0.083** (0.020)		200.7		1	KJK	02/17/17 14:45	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1D (99-109)
Date Sampled: 02/08/17 12:05
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-02
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/13/17 18:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 2:08	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	57 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-1D (99-109)
Date Sampled: 02/08/17 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.51** (0.10)		350.1		1	JLK	02/13/17 17:45	mg/L	CB71005
Chloride	**32.5** (3.0)		9250		1	JLK	02/10/17 16:43	mg/L	CB71039
Nitrate as N	**3.28** (0.110)		353.2		5	JLK	02/08/17 22:57	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:46	mg/L	CB70837
Sulfate	**8.7** (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**1.21** (0.20)		351.2		1	EEM	02/14/17 16:34	mg/L	CB71332
Total Nitrogen	**4.48** (0.30)		4500N		5	EEM	02/14/17 16:34	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3S (50-60)
Date Sampled: 02/08/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 14:50	10	10	CB71501
Manganese	**0.180** (0.020)		200.7		1	KJK	02/17/17 14:50	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3S (50-60)
Date Sampled: 02/08/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	ND (0.050)		200.7		1	KJK	02/18/17 17:10	50	25	CB71337

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3S (50-60)
Date Sampled: 02/08/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	02/13/17 17:46	mg/L	CB71005
Chloride	**324** (30.0)		9250		10	JLK	02/10/17 16:43	mg/L	CB71039
Nitrate as N	**0.601** (0.030)		353.2		1	JLK	02/08/17 22:40	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:47	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**0.61** (0.20)		351.2		1	EEM	02/14/17 16:35	mg/L	CB71332
Total Nitrogen	**1.21** (0.22)		4500N		1	EEM	02/14/17 16:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3D (84-94)
Date Sampled: 02/08/17 10:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**34.6** (0.100)		200.7		1	KJK	02/17/17 14:54	10	10	CB71501
Manganese	**2.66** (0.020)		200.7		1	KJK	02/17/17 14:54	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3D (84-94)
Date Sampled: 02/08/17 10:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	ND (0.050)		200.7		1	KJK	02/18/17 17:26	50	25	CB71337

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3D (84-94)
Date Sampled: 02/08/17 10:25
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.63** (0.10)		350.1		1	JLK	02/13/17 17:47	mg/L	CB71005
Chloride	**159** (15.0)		9250		5	JLK	02/10/17 16:44	mg/L	CB71039
Nitrate as N	ND (0.030)		353.2		1	JLK	02/08/17 22:41	mg/L	[CALC]
Nitrite as N	**0.014** (0.010)		353.2		1	JLK	02/08/17 20:48	mg/L	CB70837
Sulfate	**14.1** (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**5.75** (0.40)		351.2		2	EEM	02/14/17 16:58	mg/L	CB71332
Total Nitrogen	**5.75** (0.42)		4500N		2	EEM	02/14/17 16:58	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (36-46)
Date Sampled: 02/08/17 15:05
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 15:10	10	10	CB71501
Manganese	**0.095** (0.020)		200.7		1	KJK	02/17/17 15:10	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (36-46)
Date Sampled: 02/08/17 15:05
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	**0.090** (0.050)		200.7		1	KJK	02/18/17 17:30	50	25	CB71337

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (36-46)
Date Sampled: 02/08/17 15:05
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-05
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/14/17 15:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 2:43	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	54 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (36-46)
Date Sampled: 02/08/17 15:05
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.11** (0.10)		350.1		1	JLK	02/13/17 17:49	mg/L	CB71005
Chloride	**55.1** (3.0)		9250		1	JLK	02/10/17 16:45	mg/L	CB71039
Dissolved Organic Carbon (Average)	**4.42** (0.500)		5310B		1	DEL	02/10/17 19:03	mg/L	[CALC]
Nitrate as N	**5.52** (0.210)		353.2		10	JLK	02/08/17 23:06	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:49	mg/L	CB70837
Sulfate	**37.8** (10.0)		9038		2	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**2.03** (0.20)		351.2		1	EEM	02/14/17 16:36	mg/L	CB71332
Total Nitrogen	**7.55** (0.40)		4500N		10	EEM	02/14/17 16:36	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 02/08/17 13:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 15:14	10	10	CB71501
Manganese	**0.491** (0.020)		200.7		1	KJK	02/17/17 15:14	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 02/08/17 13:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	ND (0.050)		200.7		1	KJK	02/18/17 17:34	50	25	CB71337

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 02/08/17 13:20
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-06
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/14/17 15:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 3:18	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	48 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 02/08/17 13:20
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.34** (0.10)		350.1		1	JLK	02/13/17 17:50	mg/L	CB71005
Chloride	**65.5** (3.0)		9250		1	JLK	02/10/17 16:45	mg/L	CB71039
Dissolved Organic Carbon (Average)	**1.55** (0.500)		5310B		1	DEL	02/10/17 19:15	mg/L	[CALC]
Nitrate as N	**20.2** (2.01)		353.2		100	JLK	02/08/17 23:09	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:51	mg/L	CB70837
Sulfate	**15.5** (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**2.83** (0.20)		351.2		1	EEM	02/14/17 16:37	mg/L	CB71332
Total Nitrogen	**23.0** (2.20)		4500N		100	EEM	02/14/17 16:37	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 02/08/17 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/17/17 15:18	10	10	CB71501
Manganese	**0.072** (0.020)		200.7		1	KJK	02/17/17 15:18	10	10	CB71501

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 02/08/17 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 3005A
All methods used are in accordance with 40 CFR 136.

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Boron	ND (0.050)		200.7		1	KJK	02/18/17 17:39	50	25	CB71337

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 02/08/17 14:10
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-07
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 2/14/17 15:30

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	02/15/17 3:54	C7B0188	CB71341

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	62 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 02/08/17 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 1702187
ESS Laboratory Sample ID: 1702187-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	02/13/17 17:51	mg/L	CB71005
Chloride	**42.9** (3.0)		9250		1	JLK	02/10/17 16:47	mg/L	CB71039
Dissolved Organic Carbon (Average)	ND (0.500)		5310B		1	DEL	02/10/17 19:27	mg/L	[CALC]
Nitrate as N	**2.44** (0.110)		353.2		5	JLK	02/08/17 23:01	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	02/08/17 20:52	mg/L	CB70837
Sulfate	ND (5.0)		9038		1	JLK	02/13/17 17:30	mg/L	CB71323
Total Kjeldahl Nitrogen as N	**0.85** (0.20)		351.2		1	EEM	02/14/17 16:38	mg/L	CB71332
Total Nitrogen	**3.29** (0.30)		4500N		5	EEM	02/14/17 16:38	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CB71501 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.33		mg/L	2.500		93	80-120			
Manganese	0.455		mg/L	0.5000		91	80-120			
Total Metals										
Batch CB71337 - 3005A										
Blank										
Boron	ND	0.050	mg/L							
LCS										
Boron	0.251	0.050	mg/L	0.2500		100	85-115			
LCS Dup										
Boron	0.259	0.050	mg/L	0.2500		103	85-115	3	20	
8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution										
Batch CB71341 - 3535A										
Blank										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	*3.11*		ug/L	*5.000*		*62*	*15-115*			
LCS										
1,4-Dioxane	10.9	0.250	ug/L	10.00		109	40-140			
Surrogate: 1,4-Dioxane-d8	*3.41*		ug/L	*5.000*		*68*	*15-115*			
LCS Dup										
1,4-Dioxane	10.7	0.250	ug/L	10.00		107	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	*3.46*		ug/L	*5.000*		*69*	*15-115*			
Classical Chemistry										
Batch CB70837 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.247		mg/L	0.2497		99	90-110			
Nitrite as N	0.247		mg/L	0.2497		99	90-110			
Batch CB70838 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CB70838 - General Preparation										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.483		mg/L							
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Nitrate/Nitrite as N	0.483		mg/L	0.5000		97	90-110			
Total Nitrogen	0.483		mg/L							
Batch CB71005 - General Preparation										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
LCS										
Ammonia as N	1.10	0.10	mg/L	0.9994		110	80-120			
Batch CB71037 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
Dissolved Organic Carbon (Average)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.70	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.86	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (Average)	4.78	0.500	mg/L							
LCS Dup										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	2	200	
Dissolved Organic Carbon (2)	4.84	0.500	mg/L	5.000		97	80-120	0.3	200	
Dissolved Organic Carbon (Average)	4.82	0.500	mg/L							
Batch CB71039 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	31.4		mg/L	30.00		105	90-110			
Batch CB71323 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.5		mg/L	9.988		95	85-115			
Batch CB71332 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CB71332 - TKN Prep										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Kjeldahl Nitrogen as N	20.8	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.8	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1702187

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1702187

Turn Time _____Standard Other_____

Regulatory State: MA RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM	Project # 60476644	Project Name Orleans Landfill Phase I	
Contact Person Julianne Mamon	Address 250 Apollo DR		
City Chelmsford	State MA	Zip 01824	PO # 170115
Tel. 978-905-2419	Fax	email: Julianne.mamon@aecom.com	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: NH4, TN	NO2, NO3, SO4, Cl, TN	1,4 Dioxane	Diss LF Metals	Boron	DOC					
1	02/8/17	1140	G	GW	MW-1S(56-66)					X	X	X	X							
2	02/8/17	1205	G	GW	MW-1D(99-109)					X	X	X	X							
3	02/8/17	0955	G	GW	MW-3S(50-60)					X	X		X	X						
4	02/8/17	1025	G	GW	MW-3D(84-94)					X	X		X	X						
5	02/8/17	1505	G	GW	MW-8(36-46)					X	X	X	X	X	X					
6	02/8/17	1320	G	GW	MW-9(92-102)					X	X	X	X	X	X					
7	02/8/17	1410	G	GW	MW-10(85-95)					X	X	X	X	X	X					

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____No

Seals Intact ____ Yes ____No NA:___

Cooler Temperature: 2-8 2.6 3.1 ice KB

Internal Use Only

[✓] Pickup

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : C. Hayden

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
C Hayden 2/8/17 / 1625	2/8/17 16:25	2/8/17 17:50	2/8/17 1755
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1703684

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

SAMPLE RECEIPT

The following samples were received on March 29, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1703684-01	MW-7S (55-65)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-02	MW-7D (115-125)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-03	MW-7 (90-100)	Ground Water	200.7, 350.1, 353.2, 4500N, 8270D SIM, 9038, 9250, RSK175
1703684-04	MW-6A (64-74)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-05	MW-6B (54-64)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-06	MW-E6 (88-98)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-07	MW-2 (140-150)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-08	MW-2 (160-170)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-09	MW-2S (84-94)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-10	MW-2D (124-134)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-11	MW-10 (85-95)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-12	LS-1	Ground Water	350.1, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.216** (0.100)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946
Manganese	**0.031** (0.020)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946

ESS Laboratory
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BAL Laboratory
The Microbiology Division
of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.15** (0.10)		350.1		1	EEM	03/31/17 14:51	mg/L	CC73019
Chloride	**369** (30.0)		9250		10	EEM	03/30/17 15:48	mg/L	CC73028
Nitrate as N	**4.96** (0.210)		353.2		10	JLK	03/30/17 19:22	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	03/29/17 17:38	mg/L	CC72951
Sulfate	**15.5** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**8.67** (0.40)		4500N		10	JLK	04/03/17 21:26	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:46	C7D0026	CD70409

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BAL Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**17.5** (0.100)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946
Manganese	**2.72** (0.020)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**2.59** (0.10)		350.1		1	EEM	04/04/17 12:25	mg/L	CD70303
Chloride	**57.2** (3.0)		9250		1	EEM	03/30/17 15:28	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:40	mg/L	CC72951
Sulfate	**34.2** (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**0.57** (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:52	C7D0026	CD70409

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**7.51** (0.100)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946
Manganese	**0.331** (0.020)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 3/30/17 17:20

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	03/31/17 14:14	C7C0505	CC72972

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	44 %		15-115

ESS Laboratory
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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.19** (0.10)		350.1		1	EEM	04/04/17 12:26	mg/L	CD70303
Chloride	**428** (60.0)		9250		20	EEM	03/30/17 15:55	mg/L	CC73028
Nitrate as N	**0.154** (0.030)		353.2		1	JLK	03/30/17 19:26	mg/L	[CALC]
Nitrite as N	**0.015** (0.010)		353.2		1	JLK	03/29/17 17:41	mg/L	CC72951
Sulfate	**18.7** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**1.06** (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 10:08	C7D0026	CD70409

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 03/28/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946
Manganese	**0.050** (0.020)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 03/28/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:27	mg/L	CD70303
Chloride	**331** (30.0)		9250		10	EEM	03/30/17 15:56	mg/L	CC73028
Nitrate as N	**2.61** (0.110)		353.2		5	JLK	03/30/17 19:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:42	mg/L	CC72951
Sulfate	**27.8** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**3.94** (0.30)		4500N		5	JLK	04/03/17 21:28	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 03/28/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946
Manganese	**0.026** (0.020)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 03/28/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:30	mg/L	CD70303
Chloride	**167** (30.0)		9250		10	EEM	03/30/17 15:58	mg/L	CC73028
Nitrate as N	**8.27** (0.210)		353.2		10	JLK	03/30/17 19:28	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:43	mg/L	CC72951
Sulfate	**43.5** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**36.3** (2.20)		4500N		10	JLK	04/03/17 21:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-E6 (88-98)
Date Sampled: 03/28/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**13.5** (0.100)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946
Manganese	**2.39** (0.020)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-E6 (88-98)
Date Sampled: 03/28/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**22.6** (1.00)		350.1		10	EEM	04/04/17 13:00	mg/L	CD70303
Chloride	**196** (30.0)		9250		10	EEM	03/30/17 15:59	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:31	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:44	mg/L	CC72951
Sulfate	**21.5** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**13.6** (1.02)		4500N		5	JLK	04/03/17 21:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 03/28/17 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.908** (0.100)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946
Manganese	**5.12** (0.020)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946

ESS Laboratory
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BAL Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 03/28/17 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.2** (1.00)		350.1		10	EEM	04/04/17 13:01	mg/L	CD70303
Chloride	**46.1** (3.0)		9250		1	EEM	03/30/17 15:34	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:50	mg/L	CC72951
Sulfate	**63.5** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**17.2** (1.02)		4500N		5	JLK	04/03/17 21:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 03/28/17 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.647** (0.100)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946
Manganese	**6.72** (0.020)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 03/28/17 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**13.7** (1.00)		350.1		10	EEM	04/04/17 13:02	mg/L	CD70303
Chloride	**43.6** (3.0)		9250		1	EEM	03/30/17 15:39	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:51	mg/L	CC72951
Sulfate	**32.8** (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.45** (0.22)		4500N		1	JLK	04/03/17 21:31	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 03/28/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946
Manganese	**0.528** (0.020)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946

ESS Laboratory
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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 03/28/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:42	mg/L	CD70303
Chloride	**94.8** (3.0)		9250		1	EEM	03/30/17 15:40	mg/L	CC73028
Nitrate as N	**1.05** (0.050)		353.2		2	JLK	03/30/17 20:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:52	mg/L	CC72951
Sulfate	**81.0** (50.0)		9038		10	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**14.7** (1.04)		4500N		5	JLK	04/03/17 21:53	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 03/28/17 15:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946
Manganese	**4.48** (0.020)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946

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BAL Laboratory
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CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 03/28/17 15:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**10.9** (1.00)		350.1		10	EEM	04/04/17 13:12	mg/L	CD70303
Chloride	**134** (30.0)		9250		10	EEM	03/30/17 16:00	mg/L	CC73028
Nitrate as N	**2.32** (0.110)		353.2		5	JLK	03/30/17 20:24	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:53	mg/L	CC72951
Sulfate	**51.0** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.89** (0.30)		4500N		5	JLK	04/03/17 21:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 03/28/17 17:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.375** (0.100)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946
Manganese	**0.028** (0.020)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946

ESS Laboratory
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BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 03/28/17 17:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:44	mg/L	CD70303
Chloride	**39.1** (3.0)		9250		1	EEM	03/30/17 15:42	mg/L	CC73028
Nitrate as N	**2.50** (0.110)		353.2		5	JLK	03/30/17 20:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Sulfate	**6.1** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.83** (0.30)		4500N		5	JLK	04/04/17 18:23	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: LS-1
Date Sampled: 03/28/17 09:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-12
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.94** (0.10)		350.1		1	EEM	04/04/17 12:45	mg/L	CD70303
Nitrate as N	**1.20** (0.110)		353.2		5	JLK	03/30/17 20:26	mg/L	[CALC]
Nitrite as N	**0.428** (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Total Nitrogen	**98.5** (10.1)		4500N		50	JLK	04/04/17 18:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CC72946 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.49		mg/L	2.500		100	80-120			
Manganese	0.502		mg/L	0.5000		100	80-120			
8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution										
Batch CC72972 - 3535A										
Blank										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	*2.46*		ug/L	*5.000*		*49*	*15-115*			
LCS										
1,4-Dioxane	11.1	0.250	ug/L	10.00		111	40-140			
Surrogate: 1,4-Dioxane-d8	*2.86*		ug/L	*5.000*		*57*	*15-115*			
LCS Dup										
1,4-Dioxane	11.4	0.250	ug/L	10.00		114	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	*3.04*		ug/L	*5.000*		*61*	*15-115*			
Classical Chemistry										
Batch CC72951 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Batch CC73019 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
LCS										
Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
Batch CC73028 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	31.0		mg/L	30.00		103	90-110			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CC73032 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.6		mg/L	9.988		96	85-115			
Batch CC73050 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.506		mg/L							
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Total Nitrogen	0.506		mg/L							
Batch CC73110 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.9	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.9	2.00	mg/L							
Batch CD70303 - General Preparation										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		98	80-120			
LCS										
Ammonia as N	1.03	0.10	mg/L	0.9994		103	80-120			
Batch CD70351 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.9	2.00	mg/L	18.80		85	80-120			
Total Nitrogen	15.9	2.00	mg/L							
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch CD70409 - No Prep										
Blank										
Methane	ND	2.0	ug/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch CD70409 - No Prep										
LCS										
Methane	24.8		ug/L	36.00		69	60-140			
LCS Dup										
Methane	22.0		ug/L	36.00		61	60-140	12	30	

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Items for Project Management Review

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution
Classical Chemistry

1703684-01	Sampled->Prepared > 2.00 days
1703684-02	Sampled->Prepared > 2.00 days
1703684-03	Sampled->Prepared > 2.00 days
1703684-04	Sampled->Prepared > 2.00 days
1703684-05	Sampled->Prepared > 2.00 days
1703684-06	Sampled->Prepared > 2.00 days
1703684-07	Sampled->Prepared > 2.00 days
1703684-08	Sampled->Prepared > 2.00 days
1703684-09	Sampled->Prepared > 2.00 days
1703684-10	Sampled->Prepared > 2.00 days
1703684-11	Sampled->Prepared > 2.00 days
1703684-12	Sampled->Prepared > 2.00 days

Dissolved Metals

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

1703684-01	Missing Ethene
	Missing Ethane
1703684-02	Missing Ethene
	Missing Ethane
1703684-03	Missing Ethene
	Missing Ethane

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

PROJECT COMPLETION CHECKLIST

All Reports:

1. Has Report been Paginated?	Yes	No	
2. Has Report been Digitally Signed?	Yes	No	
3. Has MCP/RPC Sheet been filled out?	Yes	No	N/A
4. Have PRM and Fax Sheet been removed from the Project?	Yes	No	
5. Is the correct Chain of Custody attached to the Report?	Yes	No	
6. Is the correct Cooler Receipt attached to the Report?	Yes	No	N/A

Contact Person: _____ EDD:_____

E-Mail: _____

1. Does e-mail address in Element match the COC/CSR?	Yes	No	
1a. If No, did you contact Customer Service?	Yes	No	N/A
2. Are their any CCs for the report?	Yes	No	
3a If Yes, did you include them?	Yes	No	N/A
4. Did you save a copy of the e-mail in the Work Order Folder?	Yes	No	

Client Connect: _____

1. Did you save Report in CORRECT ClientConnect Folder?	Yes	No	N/A
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ESS Laboratory

Division of Thielsch Engineering, Inc.

FAX

Date: _____

To: Julianne Marrion

Company: AECOM Environment - ENSR

Project Name: Orleans MA

ESS Work Order: 1703684

Fax: (978) 589-3100

Comments:

_____

_____

_____

_____

_____

_____

Our certified laboratory provides a full range of services, including the following:

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- -Trace Metals (ICAP/Furnace) Analysis
- -Inorganic Analysis by Classic Methods, Flow Analyzer, and Ion Chromatography
- -Organics by GC/Mass Spectroscopy
- -Microbiology Analysis
- -Massachusetts EPH/VPH Analysis
- -Siloxanes
- -Field Screening and Sample Technician Services

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185 Frances Avenue, Cranston, RI 02910-2211 Tel: 401-461-7181 Fax: 401-461-4486 http://www.ESSLaboratory.com

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1703684

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.



Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 9:29 am, May 02, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

SAMPLE RECEIPT

The following samples were received on March 29, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Revision 1 May 2, 2017: This report has been revised to include TKN for sample 1703684-12.

Lab Number	Sample Name	Matrix	Analysis
1703684-01	MW-7S (55-65)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-02	MW-7D (115-125)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250, RSK175
1703684-03	MW-7 (90-100)	Ground Water	200.7, 350.1, 353.2, 4500N, 8270D SIM, 9038, 9250, RSK175
1703684-04	MW-6A (64-74)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-05	MW-6B (54-64)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-06	MW-E6 (88-98)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-07	MW-2 (140-150)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-08	MW-2 (160-170)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-09	MW-2S (84-94)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-10	MW-2D (124-134)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-11	MW-10 (85-95)	Ground Water	200.7, 350.1, 353.2, 4500N, 9038, 9250
1703684-12	LS-1	Ground Water	350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

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Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.216** (0.100)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946
Manganese	**0.031** (0.020)		200.7		1	KJK	03/29/17 17:28	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.15** (0.10)		350.1		1	EEM	03/31/17 14:51	mg/L	CC73019
Chloride	**369** (30.0)		9250		10	EEM	03/30/17 15:48	mg/L	CC73028
Nitrate as N	**4.96** (0.210)		353.2		10	JLK	03/30/17 19:22	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	03/29/17 17:38	mg/L	CC72951
Sulfate	**15.5** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**8.67** (0.40)		4500N		10	JLK	04/03/17 21:26	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7S (55-65)
Date Sampled: 03/28/17 09:55
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-01
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:46	C7D0026	CD70409

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**17.5** (0.100)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946
Manganese	**2.72** (0.020)		200.7		1	KJK	03/29/17 17:32	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**2.59** (0.10)		350.1		1	EEM	04/04/17 12:25	mg/L	CD70303
Chloride	**57.2** (3.0)		9250		1	EEM	03/30/17 15:28	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:40	mg/L	CC72951
Sulfate	**34.2** (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**0.57** (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7D (115-125)
Date Sampled: 03/28/17 10:00
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-02
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 9:52	C7D0026	CD70409

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**7.51** (0.100)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946
Manganese	**0.331** (0.020)		200.7		1	KJK	03/29/17 17:36	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A
Initial Volume: 500
Final Volume: 0.5
Extraction Method: 3535A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: ug/L
Analyst: VSC
Prepared: 3/30/17 17:20

All methods used are in accordance with 40 CFR 136.

8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
1,4-Dioxane	ND (0.250)		8270D SIM		1	03/31/17 14:14	C7C0505	CC72972

	%Recovery	Qualifier	Limits
Surrogate: 1,4-Dioxane-d8	44 %		15-115

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.19** (0.10)		350.1		1	EEM	04/04/17 12:26	mg/L	CD70303
Chloride	**428** (60.0)		9250		20	EEM	03/30/17 15:55	mg/L	CC73028
Nitrate as N	**0.154** (0.030)		353.2		1	JLK	03/30/17 19:26	mg/L	[CALC]
Nitrite as N	**0.015** (0.010)		353.2		1	JLK	03/29/17 17:41	mg/L	CC72951
Sulfate	**18.7** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**1.06** (0.22)		4500N		1	JLK	04/03/17 21:27	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 03/28/17 10:45
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-03
Sample Matrix: Ground Water
Units: ug/L
Analyst: ZLC
Prepared: 4/4/17 8:39

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Methane	ND (2.0)		RSK175		1	ZLC	04/04/17 10:08	C7D0026	CD70409

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 03/28/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946
Manganese	**0.050** (0.020)		200.7		1	KJK	03/29/17 17:40	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6A (64-74)
Date Sampled: 03/28/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:27	mg/L	CD70303
Chloride	**331** (30.0)		9250		10	EEM	03/30/17 15:56	mg/L	CC73028
Nitrate as N	**2.61** (0.110)		353.2		5	JLK	03/30/17 19:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:42	mg/L	CC72951
Sulfate	**27.8** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**3.94** (0.30)		4500N		5	JLK	04/03/17 21:28	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 03/28/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946
Manganese	**0.026** (0.020)		200.7		1	KJK	03/29/17 17:44	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6B (54-64)
Date Sampled: 03/28/17 11:40
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:30	mg/L	CD70303
Chloride	**167** (30.0)		9250		10	EEM	03/30/17 15:58	mg/L	CC73028
Nitrate as N	**8.27** (0.210)		353.2		10	JLK	03/30/17 19:28	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:43	mg/L	CC72951
Sulfate	**43.5** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**36.3** (2.20)		4500N		10	JLK	04/03/17 21:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-E6 (88-98)
Date Sampled: 03/28/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**13.5** (0.100)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946
Manganese	**2.39** (0.020)		200.7		1	KJK	03/29/17 19:54	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-E6 (88-98)
Date Sampled: 03/28/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**22.6** (1.00)		350.1		10	EEM	04/04/17 13:00	mg/L	CD70303
Chloride	**196** (30.0)		9250		10	EEM	03/30/17 15:59	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:31	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:44	mg/L	CC72951
Sulfate	**21.5** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**13.6** (1.02)		4500N		5	JLK	04/03/17 21:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 03/28/17 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.908** (0.100)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946
Manganese	**5.12** (0.020)		200.7		1	KJK	03/29/17 19:59	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 03/28/17 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.2** (1.00)		350.1		10	EEM	04/04/17 13:01	mg/L	CD70303
Chloride	**46.1** (3.0)		9250		1	EEM	03/30/17 15:34	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:50	mg/L	CC72951
Sulfate	**63.5** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**17.2** (1.02)		4500N		5	JLK	04/03/17 21:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 03/28/17 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.647** (0.100)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946
Manganese	**6.72** (0.020)		200.7		1	KJK	03/29/17 20:03	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 03/28/17 14:35
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**13.7** (1.00)		350.1		10	EEM	04/04/17 13:02	mg/L	CD70303
Chloride	**43.6** (3.0)		9250		1	EEM	03/30/17 15:39	mg/L	CC73028
Nitrate as N	ND (0.030)		353.2		1	JLK	03/30/17 19:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:51	mg/L	CC72951
Sulfate	**32.8** (10.0)		9038		2	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.45** (0.22)		4500N		1	JLK	04/03/17 21:31	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 03/28/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946
Manganese	**0.528** (0.020)		200.7		1	KJK	03/29/17 20:19	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S (84-94)
Date Sampled: 03/28/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:42	mg/L	CD70303
Chloride	**94.8** (3.0)		9250		1	EEM	03/30/17 15:40	mg/L	CC73028
Nitrate as N	**1.05** (0.050)		353.2		2	JLK	03/30/17 20:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:52	mg/L	CC72951
Sulfate	**81.0** (50.0)		9038		10	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**14.7** (1.04)		4500N		5	JLK	04/03/17 21:53	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 03/28/17 15:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946
Manganese	**4.48** (0.020)		200.7		1	KJK	03/29/17 20:23	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2D (124-134)
Date Sampled: 03/28/17 15:45
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**10.9** (1.00)		350.1		10	EEM	04/04/17 13:12	mg/L	CD70303
Chloride	**134** (30.0)		9250		10	EEM	03/30/17 16:00	mg/L	CC73028
Nitrate as N	**2.32** (0.110)		353.2		5	JLK	03/30/17 20:24	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:53	mg/L	CC72951
Sulfate	**51.0** (25.0)		9038		5	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.89** (0.30)		4500N		5	JLK	04/03/17 21:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 03/28/17 17:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-11
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.375** (0.100)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946
Manganese	**0.028** (0.020)		200.7		1	KJK	03/29/17 20:40	10	10	CC72946

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-10 (85-95)
Date Sampled: 03/28/17 17:15
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	04/04/17 12:44	mg/L	CD70303
Chloride	**39.1** (3.0)		9250		1	EEM	03/30/17 15:42	mg/L	CC73028
Nitrate as N	**2.50** (0.110)		353.2		5	JLK	03/30/17 20:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Sulfate	**6.1** (5.0)		9038		1	EEM	03/30/17 17:30	mg/L	CC73032
Total Nitrogen	**2.83** (0.30)		4500N		5	JLK	04/04/17 18:23	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: LS-1
Date Sampled: 03/28/17 09:00
Percent Solids: N/A

ESS Laboratory Work Order: 1703684
ESS Laboratory Sample ID: 1703684-12
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.94** (0.10)		350.1		1	EEM	04/04/17 12:45	mg/L	CD70303
Nitrate as N	**1.20** (0.110)		353.2		5	JLK	03/30/17 20:26	mg/L	[CALC]
Nitrite as N	**0.428** (0.010)		353.2		1	JLK	03/29/17 17:54	mg/L	CC72951
Total Kjeldahl Nitrogen as N	**96.8** (10.0)		351.2		50	JLK	04/04/17 18:42	mg/L	CD70351
Total Nitrogen	**98.5** (10.1)		4500N		50	JLK	04/04/17 18:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CC72946 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.49		mg/L	2.500		100	80-120			
Manganese	0.502		mg/L	0.5000		100	80-120			
8270D(SIM) Semi-Volatile Organic Compounds w/ Isotope Dilution										
Batch CC72972 - 3535A										
Blank										
1,4-Dioxane	ND	0.250	ug/L							
Surrogate: 1,4-Dioxane-d8	*2.46*		ug/L	*5.000*		*49*	*15-115*			
LCS										
1,4-Dioxane	11.1	0.250	ug/L	10.00		111	40-140			
Surrogate: 1,4-Dioxane-d8	*2.86*		ug/L	*5.000*		*57*	*15-115*			
LCS Dup										
1,4-Dioxane	11.4	0.250	ug/L	10.00		114	40-140	2	20	
Surrogate: 1,4-Dioxane-d8	*3.04*		ug/L	*5.000*		*61*	*15-115*			
Classical Chemistry										
Batch CC72951 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Nitrite as N	0.248		mg/L	0.2497		99	90-110			
Batch CC73019 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.09	0.10	mg/L	0.09994		91	80-120			
LCS										
Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
Batch CC73028 - General Preparation										
Blank										
Chloride	ND	3.0	mg/L							
LCS										
Chloride	31.0		mg/L	30.00		103	90-110			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CC73032 - General Preparation										
Blank										
Sulfate	ND	5.0	mg/L							
LCS										
Sulfate	9.6		mg/L	9.988		96	85-115			
Batch CC73050 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.506		mg/L							
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.506		mg/L	0.5000		101	90-110			
Total Nitrogen	0.506		mg/L							
Batch CC73110 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.9	2.00	mg/L	18.80		111	80-120			
Total Nitrogen	20.9	2.00	mg/L							
Batch CD70303 - General Preparation										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		98	80-120			
LCS										
Ammonia as N	1.03	0.10	mg/L	0.9994		103	80-120			
Batch CD70351 - [CALC]										
Blank										
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Nitrogen	15.9	2.00	mg/L							
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch CD70409 - No Prep										
Blank										
Methane	ND	2.0	ug/L							
LCS										
Methane	24.8		ug/L	36.00		69	60-140			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch CD70409 - No Prep										
LCS Dup										
Methane	22.0		ug/L	36.00		61	60-140	12	30	

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
ESS Laboratory Work Order: 1703684

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1703684

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1703684
Date Received: 3/29/2017
Project Due Date: 4/5/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 5.7 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? No
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? (Yes) / No
    a. Air bubbles in aqueous VOAs? Yes / (No)
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

COC = MW-2(160-170) label = MW-2(161-171) VK 3/29/17

14. Was there a need to contact Project Manager? (Yes) / No VK 3/29/17
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	113626	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	113638	Yes	NA	Yes	500 mL Poly - Unpres	NP	
01	113649	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	113656	Yes	No	Yes	VOA Vial - HCl	HCl	
01	113657	Yes	No	Yes	VOA Vial - HCl	HCl	
02	113625	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	113637	Yes	NA	Yes	500 mL Poly - Unpres	NP	
02	113648	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	113654	Yes	No	Yes	VOA Vial - HCl	HCl	
02	113655	Yes	No	Yes	VOA Vial - HCl	HCl	
03	113624	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	113636	Yes	NA	Yes	500 mL Poly - Unpres	NP	
03	113647	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	113650	Yes	NA	Yes	1L Amber - Unpres	NP	
03	113651	Yes	NA	Yes	1L Amber - Unpres	NP	
03	113652	Yes	No	Yes	VOA Vial - HCl	HCl	
03	113653	Yes	No	Yes	VOA Vial - HCl	HCl	
04	113623	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	113635	Yes	NA	Yes	500 mL Poly - Unpres	NP	
04	113646	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	113622	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
05	113634	Yes	NA	Yes	500 mL Poly - Unpres	NP	
05	113645	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	113621	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1703684

Date Received: 3/29/2017

06	113633	Yes	NA	Yes	500 mL Poly - Unpres	NP
06	113644	Yes	NA	Yes	250 mL Poly - Unpres	NP
07	113620	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
07	113632	Yes	NA	Yes	500 mL Poly - Unpres	NP
07	113643	Yes	NA	Yes	250 mL Poly - Unpres	NP
08	113619	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
08	113631	Yes	NA	Yes	500 mL Poly - Unpres	NP
08	113642	Yes	NA	Yes	250 mL Poly - Unpres	NP
09	113618	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
09	113630	Yes	NA	Yes	500 mL Poly - Unpres	NP
09	113641	Yes	NA	Yes	250 mL Poly - Unpres	NP
10	113617	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
10	113629	Yes	NA	Yes	500 mL Poly - Unpres	NP
10	113640	Yes	NA	Yes	250 mL Poly - Unpres	NP
11	113616	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
11	113628	Yes	NA	Yes	500 mL Poly - Unpres	NP
11	113639	Yes	NA	Yes	250 mL Poly - Unpres	NP
12	113615	Yes	NA	Yes	1L Poly - H2SO4	H2SO4
12	113627	Yes	NA	Yes	500 mL Poly - Unpres	NP

2nd Review

Are barcode labels on correct containers? (Yes) No

Completed By: _____ Date & Time: 3/29/17 0825

Reviewed By: _____ Date & Time: 3/29/17 0840

Delivered By: _____ 3/29/17 0840

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1703684

Turn Time: Rush
Regulatory State
Is this project for any of the following?: ○CT RCP ○MA MCP ○RGP
Reporting Limits
Electonic Deliverables: ☒Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name: AECOM
Contact Person: Julianne Mamon
City: Pocasset
State: MA
Telephone Number
FAX Number
Project #
Project Name: Oneans LF
Address: 9 Jonathan Bourne Dr
Zip Code: 02559
PO #
Email Address: Julianne.mamon@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: TN, Ammonia	NO_3, SO_4	Diss Metals	1,4 Dioxane	Methane
1	03/28/17	0955	G	W	MW-7S (55-65)	X	X	X		X
2	03/28/17	1000	G	GW	MW-7D (115-125)	X	X	X		X
3	03/28/17	1045	G	GW	MW-7 (90-100)	X	X	X	X	X
4	03/28/17	1100	G	GW	MW-6A (64-74)	X	X	X		
5	03/28/17	1140	G	GW	MW-6B (54-64)	X	X	X	1	
6	03/28/17	1200	G	GW	MW-6 (88-98)	X	X	X		
7	03/28/17	1535	G	GW	MW-2 (140-150)	X	X	X		
8	03/28/17	1485	G	GW	MW-2 (160-170)	X	X	X		
9	03/28/17	1515	G	GW	MW-2S (84-94)	X	X	X		
10	03/28/17	1545	G	GW	MW-2D (124-134)	X	X	X		

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial

Container Volume:	P	P	P	AG	V
Preservation Code:	6	5	3	6	7
	3	1	1	1	2
Number of Containers per Sample:	1	1	1	2	2

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Ascorbic Acid 12-Other*

Laboratory Use Only
Cooler Present: ✓
Seals Intact: NA
Cooler Temperature: 5.7/5.6 °C 11:13 3/29/17 7:08 Ice

Sampled by :
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Bradley Morrill 3/28/17 0730	3/28/17 1930	3/29/17	Nancy Ross 3/29/17 7:55
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1703684

Turn Time: Rush
Regulatory State
Is this project for any of the following?: ◉CT RCP ○MA MCP ○RGP
Reporting Limits
Electonic Deliverables: ☒Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name: AECOM
Contact Person: Julianne Mamon
Project #
Project Name: Oneans Landfill
Address: 9 Jonathan Bourne Dr
City: Pocasset
State: MA
Zip Code: 02259
PO #
Telephone Number
FAX Number
Email Address: julianne.mamon@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: TN, Ammonia	NO_2, NO_3, Cl, SO_4	Diss Metals
11	03/28/17	1715	G	GW	MW-1D (85-95)	X	X	X
12	03/28/17	0900	G	GW	LS-1	X	X	

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	G - Glass	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	5	3
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Ascorbic Acid	12-Other*	3	1	1
										Number of Containers per Sample:		1	1	1

Laboratory Use Only
Cooler Present: _____
Seals Intact: _____
Cooler Temperature: _____ °C

Sampled by :

Comments: Please specify "Other" preservative and containers types in this space
LS-1 analyze only for TN, Ammonia, NO_2, NO_3 + TKN

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
03/28/17 730	3/28/17 1830	3/29/17 0700	3/29/17 735
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1707480

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 10:50 am, Jul 28, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

SAMPLE RECEIPT

The following samples were received on July 21, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1707480-01	MW-2 (186-196)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1707480-02	MW-2 (206-216)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

Dissolved Metals

Client Sample ID: MW-2 (186-196)
Date Sampled: 07/21/17 09:35
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**0.411**	mg/L	0.100	200.7	1	BJV	07/24/17 20:53	10	10
Manganese	**0.119**	mg/L	0.020	200.7	1	BJV	07/24/17 20:53	10	10

Client Sample ID: MW-2 (206-216)
Date Sampled: 07/21/17 11:57
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**2.56**	mg/L	0.100	200.7	1	BJV	07/24/17 21:21	10	10
Manganese	**0.057**	mg/L	0.020	200.7	1	BJV	07/24/17 21:21	10	10

Classical Chemistry

Client Sample ID: MW-2 (186-196)
Date Sampled: 07/21/17 09:35
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Ammonia as N	ND	mg/L	0.10	350.1	1	EEM	07/27/17 15:58
Nitrate as N	**0.135**	mg/L	0.030	353.2	1	JLK	07/27/17 20:39
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	07/21/17 20:34
Total Kjeldahl Nitrogen as N	**0.38**	mg/L	0.20	351.2	1	EEM	07/25/17 12:26
Total Nitrogen	**0.52**	mg/L	0.22	4500N	1	EEM	07/27/17 20:39

Client Sample ID: MW-2 (206-216)
Date Sampled: 07/21/17 11:57
Percent Solids: N/A

ESS Laboratory Sample ID: 1707480-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Ammonia as N	ND	mg/L	0.10	350.1	1	EEM	07/27/17 15:59
Nitrate as N	**0.116**	mg/L	0.030	353.2	1	JLK	07/27/17 20:42
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	07/21/17 20:35
Total Kjeldahl Nitrogen as N	**0.45**	mg/L	0.20	351.2	1	EEM	07/25/17 12:33
Total Nitrogen	**0.57**	mg/L	0.22	4500N	1	EEM	07/27/17 20:42

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CG72137 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Batch CG72441 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.8	2.00	mg/L	14.20		111	80-120			
Total Kjeldahl Nitrogen as N	15.8	2.00	mg/L	14.20		111	80-120			
Total Nitrogen	15.8	2.00	mg/L							
Batch CG72513 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.12	0.10	mg/L	0.09994		120	80-120			
LCS										
Ammonia as N	0.97	0.10	mg/L	0.9994		97	80-120			
Batch CG72731 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.520		mg/L							
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Total Nitrogen	0.520		mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707480

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1707480
Date Received: 7/21/2017
Project Due Date: 7/28/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.5 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	149935	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	149937	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	149939	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	149934	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	149936	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	149938	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? Yes / No

Completed By: Date & Time: 7/21/17 1459
Reviewed By: Date & Time: 7/21/17 1513
Delivered By: 7/21/17 1513

CHAIN OF CUSTODY

PAGE 1 OF 1

ALPHA ANALYTICAL — World Class Chemistry

8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab:

ALPHA Job #: 1707480

Client Information

Client: AECOM
Address: 9 Jonathan Bourne Drive
Pocasset, MA
Phone: 508-833-6964
Email: Mark.Owen@aecom.com

Project Information

Project Name: Orleans Landfill
Project Location: Orleans, MA
Project #: 60476644
Project Manager: Mark Owen
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)
Date Due:

Additional Project Information:

Report Information - Data Deliverables

☐ ADEx ☒ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	Nitrate	Nitrite	Ammonia	Dissolved Fe	Sieve Analysis	Sample Comments	TOTAL # BOTTLES
1	MW-2 (186-196)	7-21-17	0935	GW	CH	X	X	X				3
2	MW-2 (206-216)	7-21-17	1157	GW	CH	X	X	X				3
	MW-13 / 4-8' (SB-1)	7-20-17	1200	SO	MO				X			
	MW-13 / 8-9' (SB-1)		1202	SO	MO				X			
	MW-13 / 10-16' (SB-1)		1204	SO	MO				X			
	MW-13 / 16-24' (SB-1)	↓	1206	SO	MO				X			

ANALYSIS: ☐ VOC: 8260 ☐ 624 ☐ 524.2 ☐ SVOC: ABN ☐ PAH ☐ METALS: MCP 13 ☐ MCP 14 ☐ RCP 15 ☐ METALS: RCRA5 ☐ RCRA8 ☐ PP13 ☐ EPH: Ranges & Targets ☐ Ranges Only ☐ VPH: Ranges & Targets ☐ Ranges Only ☐ PCB ☐ PEST ☐ TPH: ☐ Quant Only ☐ Fingerprint

SAMPLE INFO
Filtration
☐ Field
☐ Lab to do
Preservation
☐ Lab to do

Container Type												
Preservative												
									P	P	P	
									A	D	A	

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
C. Hayden	7-21-17/1230		7/21/17 11:54
	7-21-17 14:47		7/21/17 1453

Ice temp 3.5° 7.21.17 14:43

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1707481

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 11:17 am, Jul 28, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

Subcontracted Analyses

CTS - Cranston, RI	Sieve Analysis

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

SAMPLE RECEIPT

The following samples were received on July 21, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1707481-01	MW-13 / 4-8' (SB-1)	Soil	§
1707481-02	MW-13 / 8-9' (SB-1)	Soil	§
1707481-03	MW-13 / 10-16' (SB-1)	Soil	§
1707481-04	MW-13 / 16-24' (SB-1)	Soil	§

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

Subcontracted Analysis

Client Sample ID: MW-13 / 4-8' (SB-1)
Date Sampled: 07/20/17 12:00

ESS Laboratory Sample ID: 1707481-01
Sample Matrix: Soil

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Sieve Analysis	**See Attached**								

Client Sample ID: MW-13 / 8-9' (SB-1)
Date Sampled: 07/20/17 12:02

ESS Laboratory Sample ID: 1707481-02
Sample Matrix: Soil

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Sieve Analysis	**See Attached**								

Client Sample ID: MW-13 / 10-16' (SB-1)
Date Sampled: 07/20/17 12:04

ESS Laboratory Sample ID: 1707481-03
Sample Matrix: Soil

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Sieve Analysis	**See Attached**								

Client Sample ID: MW-13 / 16-24' (SB-1)
Date Sampled: 07/20/17 12:06

ESS Laboratory Sample ID: 1707481-04
Sample Matrix: Soil

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Sieve Analysis	**See Attached**								

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

Notes and Definitions

Z-08	See Attached
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707481

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

LABORATORY TESTING DATA SHEET

Project Name **Orleans Landfill** Location Orleans, MA Reviewed By

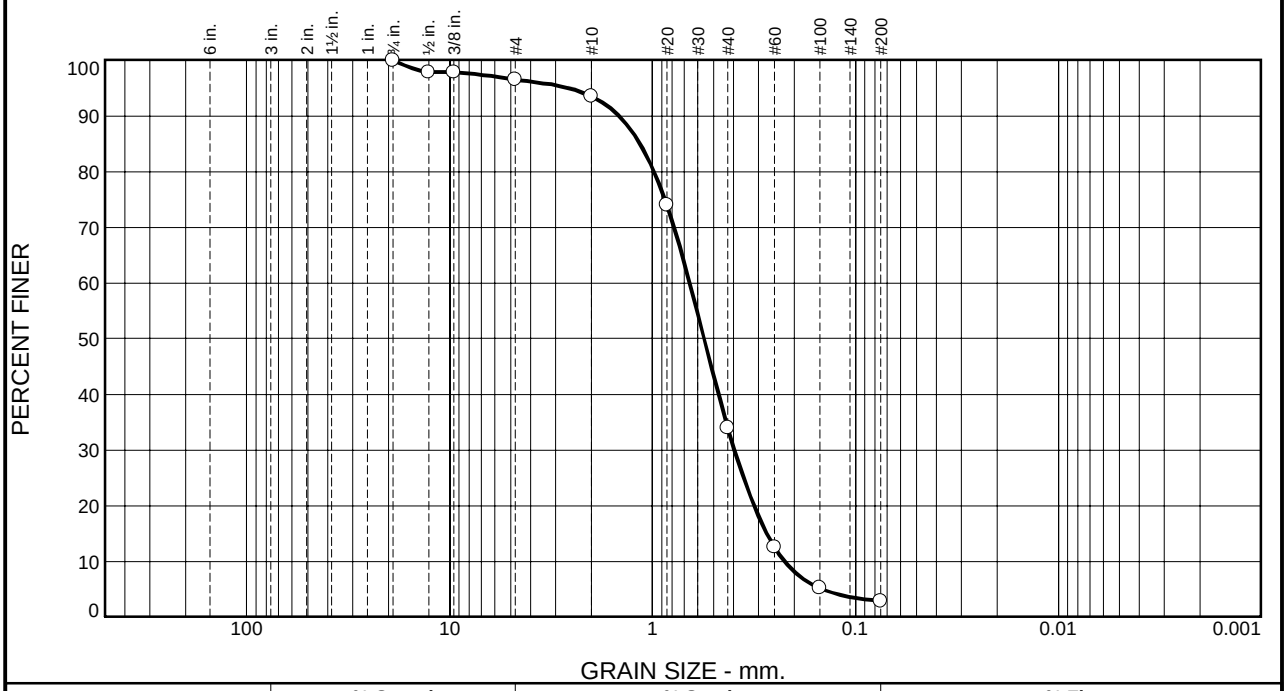
ESS Project No. **1707481** Assigned By Michelle Mirenda

Project Manager Michelle Mirenda Report Date 07.26.17 Date Reviewed *07.27.17*

Boring/ Test Pit No.	Sample No.	Depth ft.	Laboratory No.	Identification Tests							Corrosivity				
				Water Content %	LL %	PL %	Gravel %	Sand %	Fines (<#200) %	Org. %	Sulfate (mg/kg)	Chloride (mg/kg)	Resistivity (Mohms-cm)	GTL Resist	Laboratory Log and Soil Description
MW-13	1707481-01	4-8	17-S-1056				3.5	93.6	2.9						Light Brown poorly graded sand
MW-13	1707481-02	8-9	17-S-1057				6.8	72.2	21.0						Brown silty sand
MW-13	1707481-03	10-16	17-S-1058				1.9	96.1	2.0						Light Brown poorly graded sand
MW-13	1707481-04	16-24	17-S-1059				3.3	95.1	1.6						Light Brown poorly graded sand

THIELSCH ENGINEERING
195 Frances Avenue
Cranston, RI 02910 401-467-6454

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.5	3.0	59.6	31.0	2.9	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	97.8		
0.375"	97.8		
#4	96.5		
#10	93.5		
#20	74.0		
#40	33.9		
#60	12.5		
#100	5.2		
#200	2.9		

* (no specification provided)

Material Description

Light Brown poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 1.4621 D_{85}= 1.1529 D_{60}= 0.6562
D_{50}= 0.5572 D_{30}= 0.3945 D_{15}= 0.2732
D_{10}= 0.2235 u 2.94 C_c= 1.06

Remarks

Split Sample

Date Received: 07.21.17 **Date Tested:** 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Soil Samples **Depth:** 4-8' **Date Sampled:** 07.20.17

Sample Number: MW-13 / 1707481-01

Thielsch Engineering Inc.

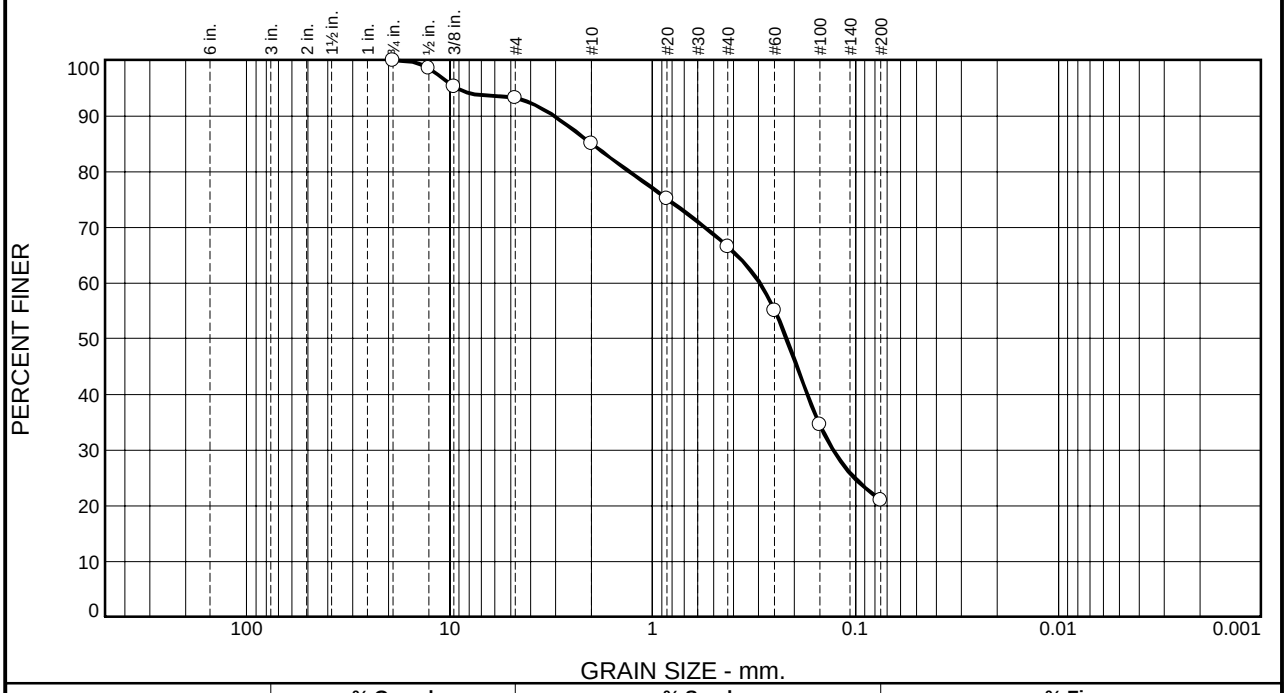
Cranston, RI

Client: ESS / AECOM

Project: Orleans Landfill
Orleans, MA

Project No: 1707481 **Figure** 17-S-1056

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.8	8.2	18.5	45.5	21.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	98.6		
0.375"	95.3		
#4	93.2		
#10	85.0		
#20	75.1		
#40	66.5		
#60	55.1		
#100	34.6		
#200	21.0		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 3.0637 D_{85}= 1.9939 D_{60}= 0.2965
D_{50}= 0.2187 D_{30}= 0.1289 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 07.21.17 **Date Tested:** 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Soil Samples **Depth:** 8-9' **Date Sampled:** 07.20.17

Sample Number: MW-13 / 1707481-02

Thielsch Engineering Inc.

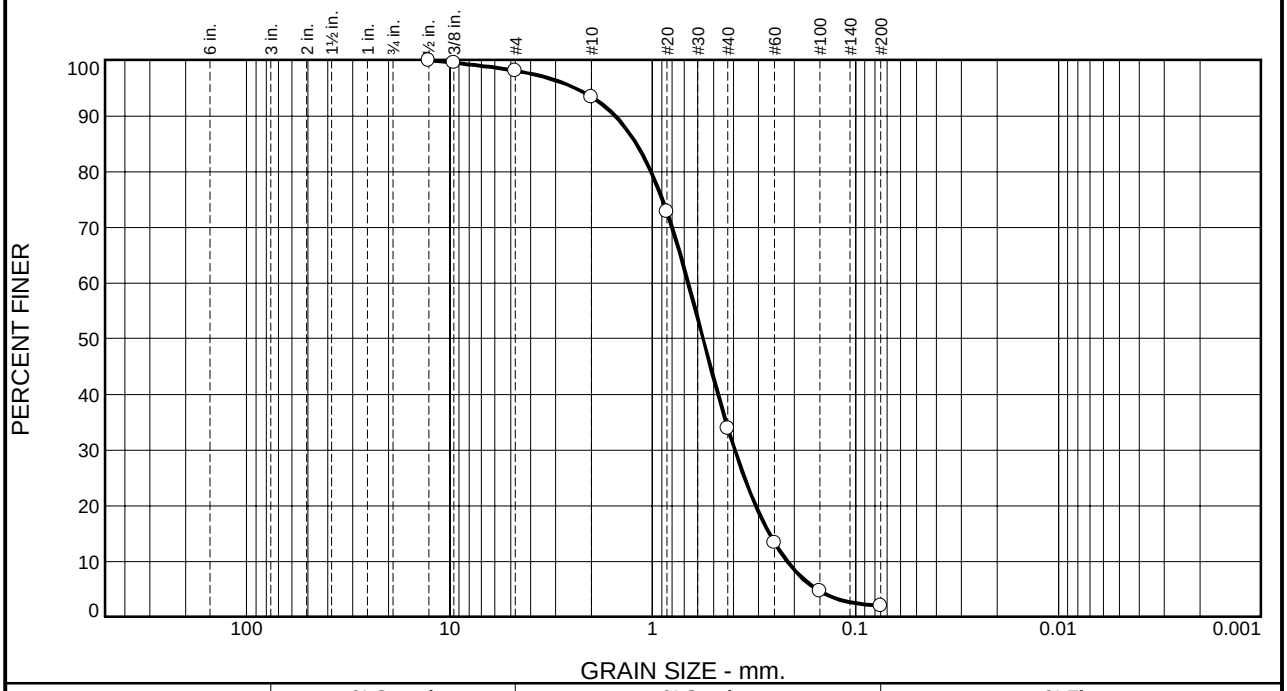
Cranston, RI

Client: ESS / AECOM

Project: Orleans Landfill
Orleans, MA

Project No: 1707481 **Figure** 17-S-1057

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	4.7	59.5	31.9	2.0	

TEST RESULTS (D6913)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.5"	100.0		
0.375"	99.6		
#4	98.1		
#10	93.4		
#20	72.8		
#40	33.9		
#60	13.3		
#100	4.7		
#200	2.0		

* (no specification provided)

Material Description

Light Brown poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 1.5296 D_{85}= 1.2009 D_{60}= 0.6671
D_{50}= 0.5635 D_{30}= 0.3931 D_{15}= 0.2654
D_{10}= 0.2167 u 3.08 C_c= 1.07

Remarks

Split Sample

Date Received: 07.21.17 **Date Tested:** 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Soil Samples **Depth:** 10-16' **Date Sampled:** 07.20.17

Sample Number: MW-13 / 1707481-03

Thielsch Engineering Inc.

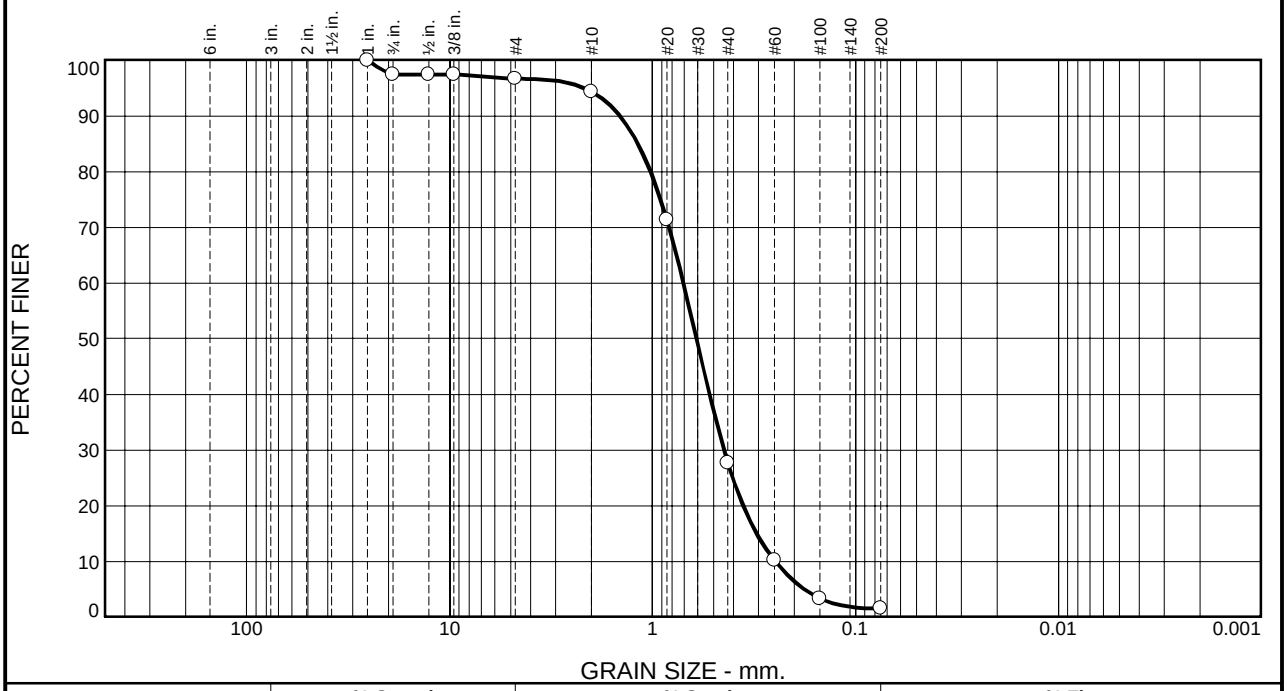
Cranston, RI

Client: ESS / AECOM

Project: Orleans Landfill
Orleans, MA

Project No: 1707481 **Figure** 17-S-1058

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.6	0.7	2.4	66.6	26.1	1.6	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	97.4		
0.5"	97.4		
0.375"	97.4		
#4	96.7		
#10	94.3		
#20	71.3		
#40	27.7		
#60	10.2		
#100	3.3		
#200	1.6		

* (no specification provided)

Material Description

Light Brown poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 1.4478 D_{85}= 1.1817 D_{60}= 0.7049
D_{50}= 0.6074 D_{30}= 0.4439 D_{15}= 0.3065
D_{10}= 0.2476 u 2.85 C_c= 1.13

Remarks

Split Sample

Date Received: 07.21.17 **Date Tested:** 07.26.17

Tested By: JAL

Checked By: Matthew Colman P.E.

Title: Laboratory Manager

Source of Sample: Soil Samples **Depth:** 16-24' **Date Sampled:** 07.20.17

Sample Number: MW-13 / 1707481-04

Thielsch Engineering Inc.

Cranston, RI

Client: ESS / AECOM

Project: Orleans Landfill
Orleans, MA

Project No: 1707481 **Figure** 17-S-1059

CHAIN OF CUSTODY

PAGE 1 OF 1

ALPHA ANALYTICAL — Right Data Right Time
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab:

ALPHA Job #: 1707481

Client Information

Client: AECOM
Address: 9 Jonathan Bourne Drive
Pocasset, MA
Phone: 508-833-6964
Email: Mark.owen@aecom.com

Project Information

Project Name: orleans landfill
Project Location: orleans, MA
Project #: 60476644
Project Manager: Mark Owen
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)
Date Due:

Additional Project Information:

Report Information - Data Deliverables

☐ ADEx ☒ EMAIL

Billing Information

☒ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC: ☐ 8260 ☐ 624 ☐ 524.2	SVOC: ☐ ABN ☐ PAH	METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15	METALS: ☐ RCRA5 ☐ RCRA8 ☐ PP13	EPH: ☐ Ranges & Targets ☐ Ranges Only	VPH: ☐ Ranges & Targets ☐ Ranges Only	☐ PCB ☐ PEST	TPH: ☐ Quant Only ☐ Fingerprint	Nitrate	Ammonia	Dissolved Fe, Mn	Sieve Analysis	Sample Comments	TOTAL # BOTTLES
	MW-2 (186-196')	7-21-17	0935	GW	CH									X	X	X			3
	MW-2 (206-216')	7-21-17	1157	GW	CH									X	X	X			3
1	MW-13 / 4-8' (SB-1)	7-20-17	1200	so	MO												X		
2	MW-13 / 8-9' (SB-1)	↓	1202	so	MO												X		
3	MW-13 / 10-16' (SB-1)		1204	so	MO												X		
4	MW-13 / 16-24' (SB-1)	↓	1206	so	MO												X		
													Container Type	P	P	P			
													Preservative	A	D	A			

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	7-21-17 1230	[signature]	7/21/17 11:54
[signature]	7-21-17 14:47	[signature]	7/21/17 1453

Tr ef emp 3.5° 7.21.17 14:47

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1707666

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 9:28 am, Aug 02, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

SAMPLE RECEIPT

The following samples were received on July 31, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1707666-01	PW-1 (95-128)	Ground Water	350.1, 351.2, 353.2, 4500N
1707666-02	PW-1 (95-128)	Ground Water	350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

Classical Chemistry

Client Sample ID: PW-1 (95-128)
Date Sampled: 07/31/17 14:45
Percent Solids: N/A

ESS Laboratory Sample ID: 1707666-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Ammonia as N	**9.44**	mg/L	1.00	350.1	10	EEM	08/01/17 14:43
Nitrate as N	**0.121**	mg/L	0.030	353.2	1	JLK	08/01/17 17:23
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	08/01/17 16:47
Total Kjeldahl Nitrogen as N	**10.1**	mg/L	1.00	351.2	5	JLK	08/01/17 19:20
Total Nitrogen	**10.2**	mg/L	1.02	4500N	5	JLK	08/01/17 19:20

Client Sample ID: PW-1 (95-128)
Date Sampled: 07/31/17 16:00
Percent Solids: N/A

ESS Laboratory Sample ID: 1707666-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Ammonia as N	**8.76**	mg/L	1.00	350.1	10	EEM	08/01/17 14:43
Nitrate as N	**0.212**	mg/L	0.030	353.2	1	JLK	08/01/17 17:24
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	08/01/17 16:48
Total Kjeldahl Nitrogen as N	**9.51**	mg/L	1.00	351.2	5	JLK	08/01/17 19:21
Total Nitrogen	**9.72**	mg/L	1.02	4500N	5	JLK	08/01/17 19:21

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CG73113 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		100	80-120			
LCS										
Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
Batch CH70109 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.4	2.00	mg/L	14.20		109	80-120			
Total Kjeldahl Nitrogen as N	15.4	2.00	mg/L	14.20		109	80-120			
Total Nitrogen	15.4	2.00	mg/L							
Batch CH70135 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
Batch CH70136 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.468		mg/L							
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Total Nitrogen	0.468		mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1707666

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1707666

Turn Time: 5-Day Rush 24 HR
Regulatory State
Is this project for any of the following?: ○CT RCP ○MA MCP ○CGP
Reporting Limits
Electonic Deliverables: ☐Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans MA - Landfill
Contact Person	**Address**	
Mark Owen	9 Jonathan Bourne Dr	
City	**State**	**Zip Code** / **PO #**
Pocasset	MA	02559
Telephone Number	**FAX Number**	**Email Address**
978-204-0983		mark.owen@aecom.com

Analysis: NO2, NO3 Amonia, TKN

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID		
1	7-31-17	2:45	Groundwater	H_2O	PW-1 (95-128)	X	
1	↓	2:45	↓	↓	↓		X
2		4:00				X	X MNO
2		4:00					X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial — B B
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other* — 6 ~~6~~ 3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, Na(9-NH4Cl 10-DI H2O 11-Other* — 1 3
Number of Containers per Sample: 1 5

Laboratory Use Only
Cooler Present:
Seals Intact: ✓
Cooler Temperature: Iretem 3.1 °C 7-31-17 18:05

Sampled by : Mark Owen
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
7/31/17 @ 4:00	7-31-17 1606	7-31-17 1806	7/31/17 1807
Relinquished by: (Signature/ Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708022

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:25 pm, Aug 03, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

SAMPLE RECEIPT

The following samples were received on August 01, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708022-01	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-02	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-03	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-04	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-05	PW-1 (95-125)	Ground Water	350.1, 351.2, 353.2, 4500N
1708022-06	PW-1 (95-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 07/31/17 20:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**8.33** (0.50)		350.1		5	JLK	08/02/17 18:08	mg/L	CH70221
Nitrate as N	**0.701** (0.030)		353.2		1	JLK	08/01/17 20:39	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	08/01/17 20:21	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**10.2** (1.00)		351.2		5	JLK	08/02/17 16:58	mg/L	CH70215
Total Nitrogen	**10.9** (1.02)		4500N		5	JLK	08/02/17 16:58	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 00:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**8.40** (0.50)		350.1		5	JLK	08/02/17 18:16	mg/L	CH70221
Nitrate as N	**1.18** (0.050)		353.2		2	JLK	08/01/17 20:46	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	08/01/17 20:21	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**10.0** (1.00)		351.2		5	JLK	08/02/17 17:00	mg/L	CH70215
Total Nitrogen	**11.2** (1.04)		4500N		5	JLK	08/02/17 17:00	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 04:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.67** (0.50)		350.1		5	JLK	08/02/17 18:17	mg/L	CH70221
Nitrate as N	**1.62** (0.110)		353.2		5	JLK	08/01/17 20:47	mg/L	[CALC]
Nitrite as N	**0.013** (0.010)		353.2		1	JLK	08/01/17 20:22	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**9.95** (1.00)		351.2		5	JLK	08/02/17 17:00	mg/L	CH70215
Total Nitrogen	**11.6** (1.10)		4500N		5	JLK	08/02/17 17:00	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 08:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.19** (0.50)		350.1		5	JLK	08/02/17 18:20	mg/L	CH70221
Nitrate as N	**1.90** (0.110)		353.2		5	JLK	08/01/17 20:47	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	08/01/17 20:23	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**9.69** (1.00)		351.2		5	JLK	08/02/17 17:01	mg/L	CH70215
Total Nitrogen	**11.6** (1.10)		4500N		5	JLK	08/02/17 17:01	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.24** (0.50)		350.1		5	JLK	08/02/17 18:21	mg/L	CH70221
Nitrate as N	**2.06** (0.110)		353.2		5	JLK	08/01/17 20:48	mg/L	[CALC]
Nitrite as N	**0.013** (0.010)		353.2		1	JLK	08/01/17 20:24	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**9.52** (1.00)		351.2		5	JLK	08/02/17 17:02	mg/L	CH70215
Total Nitrogen	**11.6** (1.10)		4500N		5	JLK	08/02/17 17:02	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 13:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**19.6** (0.100)		200.7		1	KJK	08/02/17 10:56	10	10	CH70220
Manganese	**2.59** (0.020)		200.7		1	KJK	08/02/17 10:56	10	10	CH70220

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (95-125)
Date Sampled: 08/01/17 13:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708022
ESS Laboratory Sample ID: 1708022-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.18** (0.50)		350.1		5	JLK	08/02/17 18:21	mg/L	CH70221
Nitrate as N	**2.12** (0.110)		353.2		5	JLK	08/01/17 20:54	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	JLK	08/01/17 20:25	mg/L	CH70135
Total Kjeldahl Nitrogen as N	**9.71** (1.00)		351.2		5	JLK	08/02/17 17:03	mg/L	CH70215
Total Nitrogen	**11.8** (1.10)		4500N		5	JLK	08/02/17 17:03	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH70220 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.501		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch CH70135 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
Nitrite as N	0.261		mg/L	0.2497		104	90-110			
Batch CH70136 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.468		mg/L							
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Nitrate/Nitrite as N	0.468		mg/L	0.5000		94	90-110			
Total Nitrogen	0.468		mg/L							
Batch CH70215 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	14.9	2.00	mg/L	14.20		105	80-120			
Total Kjeldahl Nitrogen as N	14.9	2.00	mg/L	14.20		105	80-120			
Total Nitrogen	14.9	2.00	mg/L							
Batch CH70221 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		114	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH70221 - NH4 Prep										
LCS										
Ammonia as N	0.86	0.10	mg/L	0.9994		86	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708022

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
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CHAIN OF CUSTODY

ESS Lab # 1708022

Turn Time _____ Standard Other 24 Hr

Regulatory State: MA RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name: AECOM
Contact Person: Mark Owen
City: Barre
State: MA
Zip: 02559
PO #:
Tel. 978 204 0983
Fax.
email: mark.owen@aecom.com

Project #: 60476644
Project Name: Orleans LF
Address: 9 Jonathan Bourne Dr

Analysis: NO_2, NO_3, Ammonia, TN, TKN, Dis. Iron, Manganese

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	NO_2	NO_3	Ammonia	TN	TKN	Dis. Iron	Manganese
1	7-31-17	8:00 pm	G	H_2O	PW-1 (95-125)	3	1	P	1L	X	X					
2	8-1-17	12:15 am	G	H_2O		3	1	P	1L	X	X					
3	8-1-17	4:15 am	G	H_2O		3	1	P	1L	X	X					
4	8-1-17	8:00 am	G	H_2O		3	1	P	1L	X	X					
5	8-1-17	11:00 am	G	H_2O		3	1	P	1L	X	X					
6	8-1-17	13:00	G	H_2O		3	1	P	1L	X	X					
1	7-31-17	8:00 pm	G			1	1	P	250	X	1					
2	8-1-17	12:15 am	G			1	1	P	250	X						
3		4:15 am	G			1	1	P	250	X						
4		8:00 am	G			1	1	P	250	X						

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ____Yes ____No

Seals Intact ____Yes ____No NA

Cooler Temperature: 6.0 ice

Internal Use Only
[ ] Pickup
[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by: Mark Owen

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
14:30 8-1-17	8/1/17 1430	8/1/17 1710	8/1/17 1716
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1706022

Turn Time _____ Standard Other 24 HR

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name: AECOM	Project #: 60476644	Project Name: Orleans LF	
Contact Person: Mark Owen	Address: 9 Jonathan Bourne		
City: Bourne	State: MA	Zip: 02559	PO #:
Tel. 978-204-0983	Fax:	email:	

Analysis: NO3, NO2, Fe, Mn

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container										
5	8-1-17	11:00	C	H_2O	PM-1 (95-125)	1	1	P	250	X									
6	8-1-17	13:00	C	H_2O	↓	1	1	P	250	X									
6	8-1-17	13:00	C	H_2O	↓	1	1	P	250		X								

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present _____Yes _____No

Seals Intact ____ Yes _____No NA: X

Cooler Temperature: 6.0 ice mx

Internal Use Only
[ ] Pickup
[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by: Mark Owen

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
14:30 8-1-17	8/1/17 1230	8/1/17 1710	8/1/17 1716
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708095

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:24 pm, Aug 07, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

SAMPLE RECEIPT

The following samples were received on August 03, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708095-01	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708095-02	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/03/17 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 1708095
ESS Laboratory Sample ID: 1708095-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**12.3** (0.50)		350.1		5	JLK	08/04/17 21:30	mg/L	CH70405
Nitrate as N	ND (0.030)		353.2		1	JLK	08/03/17 21:15	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/03/17 20:32	mg/L	CH70340
Total Kjeldahl Nitrogen as N	**14.7** (2.00)		351.2		10	EEM	08/04/17 11:53	mg/L	CH70352
Total Nitrogen	**14.7** (2.02)		4500N		10	EEM	08/04/17 11:53	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/03/17 16:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708095
ESS Laboratory Sample ID: 1708095-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.8** (0.50)		350.1		5	JLK	08/04/17 21:31	mg/L	CH70405
Nitrate as N	ND (0.030)		353.2		1	JLK	08/03/17 21:16	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/03/17 20:32	mg/L	CH70340
Total Kjeldahl Nitrogen as N	**14.8** (2.00)		351.2		10	EEM	08/04/17 11:54	mg/L	CH70352
Total Nitrogen	**14.8** (2.02)		4500N		10	EEM	08/04/17 11:54	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH70340 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.259		mg/L	0.2497		104	90-110			
Nitrite as N	0.259		mg/L	0.2497		104	90-110			
Batch CH70341 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.482		mg/L							
Nitrate/Nitrite as N	0.482		mg/L	0.5000		96	90-110			
Nitrate/Nitrite as N	0.482		mg/L	0.5000		96	90-110			
Total Nitrogen	0.482		mg/L							
Batch CH70352 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	14.0	2.00	mg/L	14.20		98	80-120			
Total Kjeldahl Nitrogen as N	14.0	2.00	mg/L	14.20		98	80-120			
Total Nitrogen	14.0	2.00	mg/L							
Batch CH70405 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		105	80-120			
LCS										
Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708095

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 708095

Turn Time 24hr Standard Other_____

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM	Project # 60476644	Project Name Orleans Landfill	
Contact Person Mark Owen	Address 9 Jonathan Bourne Drive		
City Pocasset	State MA	Zip 02559	PO #
Tel. ~~508-833~~ 978-204-0483	Fax	email: mark.owen@aecom.com	

Analysis

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	NO2 NO3	Ammonia-Nitrogen
1	8-3-17	12:05pm	G	H_2O	PW-1 (130-160)	1	21	P	250ml	X	
1	8-3-17	12:05pm	G	H_2O	PW-1 (130-160)	3	1	P	1000ml		X
2	8-3-17	4:00pm	G	H_2O	PW-1 (130-160)	1	2	P	250ml	X	
2	8-3-17	4:00pm	G	H_2O	PW-1 (130-160)	3	2	P	1000ml		X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA: X

Cooler Temperature: 2-3 Ice

Internal Use Only

[ ] Pickup

[ ] Technician

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : SC

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
[illegible] 8/3/17 1537	[illegible] 8/3/17 1537	[illegible] 8/3/17 1800	[illegible] 8/3/17 1800
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708128

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 11:35 am, Aug 08, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

SAMPLE RECEIPT

The following samples were received on August 04, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708128-01	MW-15 (155-145)	Ground Water	350.1, 351.2, 353.2, 4500N
1708128-02	MW-15 (125-115)	Ground Water	350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-15 (155-145)
Date Sampled: 08/04/17 08:51
Percent Solids: N/A

ESS Laboratory Work Order: 1708128
ESS Laboratory Sample ID: 1708128-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.80** (0.10)		350.1		1	JLK	08/07/17 17:34	mg/L	CH70708
Nitrate as N	**0.456** (0.030)		353.2		1	JLK	08/04/17 19:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:11	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**1.49** (0.20)		351.2		1	EEM	08/07/17 14:58	mg/L	CH70709
Total Nitrogen	**1.95** (0.220)		4500N		1	EEM	08/07/17 14:58	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-15 (125-115)
Date Sampled: 08/04/17 09:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708128
ESS Laboratory Sample ID: 1708128-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.55** (0.10)		350.1		1	JLK	08/07/17 17:35	mg/L	CH70708
Nitrate as N	**2.20** (0.110)		353.2		5	JLK	08/04/17 20:09	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:13	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**1.38** (0.20)		351.2		1	EEM	08/07/17 15:01	mg/L	CH70709
Total Nitrogen	**3.58** (0.300)		4500N		5	EEM	08/07/17 15:01	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH70432 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Batch CH70433 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							
Batch CH70708 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		99	80-120			
LCS										
Ammonia as N	1.19	0.10	mg/L	0.9994		119	80-120			
Batch CH70709 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Nitrogen	17.0	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708128

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708128
Date Received: 8/4/2017
Project Due Date: 8/7/2017
Days for Project: 1 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 5.3 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? No
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:
COC = MW-15(155-14), Label = MW5(145-155) 8/4/17

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	152599	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	152601	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	152598	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	152600	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

2nd Review
Are barcode labels on correct containers? Yes / No

Completed By: Date & Time: 8/4/17 1716
Reviewed By: Date & Time: 8/4/17 1732
Delivered By: 8/4/17 1732

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1708128

Turn Time 24 Standard Other_____

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM

Project # 60476644

Project Name Orleans Landfill

Contact Person Mark Owen

Address 9 Jonathan Bourne Drive

City Pocasset

State MA

Zip 02559

PO #

Tel. 978-204-0983

Fax.

email: mark.owen@aecom.com

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: NO2	Analysis: NO3	Analysis: Ammonia TN & TKN
1	8-4-17	851	G	H_2O	mw-15(155-145)	1	1	P	250 ml		X	
1	8-4-17	851	G	H_2O	mw 15(155-145	3	1	P	1000 ml			X
2	8-4-17	920	G	H_2O	mw15(125-115)	1	1	P	250 ml		X	
2	8-4-17	920	G	H_2O	mw15(125-115)	3	1	P	1000 ml			X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA ✓

Cooler Temperature: 5-3 Icem

Internal Use Only

[ ] Pickup

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by: SC

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
	8/4/17 1600	8-4-17 1600	
8/4/17 1702	8/4/17 1703		

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708129

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 2:47 pm, Aug 08, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

SAMPLE RECEIPT

The following samples were received on August 04, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708129-01	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-02	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-03	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-04	PW-1 (130-160)	Ground Water	350.1, 351.2, 353.2, 4500N
1708129-05	PW-1 (130-160)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/03/17 20:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.8** (1.00)		350.1		10	JLK	08/07/17 17:49	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 19:58	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:14	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**15.4** (2.00)		351.2		10	EEM	08/07/17 15:11	mg/L	CH70709
Total Nitrogen	**15.4** (2.02)		4500N		10	EEM	08/07/17 15:11	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/04/17 00:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**12.0** (1.00)		350.1		10	JLK	08/07/17 17:55	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 19:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:15	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**15.3** (2.00)		351.2		10	EEM	08/07/17 15:12	mg/L	CH70709
Total Nitrogen	**15.3** (2.02)		4500N		10	EEM	08/07/17 15:12	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/04/17 04:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.3** (1.00)		350.1		10	JLK	08/07/17 17:56	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:00	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:16	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**14.9** (2.00)		351.2		10	EEM	08/07/17 15:13	mg/L	CH70709
Total Nitrogen	**14.9** (2.02)		4500N		10	EEM	08/07/17 15:13	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/04/17 07:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**13.3** (1.00)		350.1		10	JLK	08/07/17 17:57	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:01	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:17	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**15.1** (2.00)		351.2		10	EEM	08/07/17 15:14	mg/L	CH70709
Total Nitrogen	**15.1** (2.02)		4500N		10	EEM	08/07/17 15:14	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/04/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**2.46** (0.100)		200.7		1	BJV	08/07/17 12:32	10	10	CH70722
Manganese	**3.48** (0.020)		200.7		1	BJV	08/07/17 12:32	10	10	CH70722

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-1 (130-160)
Date Sampled: 08/04/17 09:55
Percent Solids: N/A

ESS Laboratory Work Order: 1708129
ESS Laboratory Sample ID: 1708129-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.1** (1.00)		350.1		10	JLK	08/07/17 17:57	mg/L	CH70708
Nitrate as N	ND (0.030)		353.2		1	JLK	08/04/17 20:07	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/04/17 19:23	mg/L	CH70432
Total Kjeldahl Nitrogen as N	**15.2** (2.00)		351.2		10	EEM	08/07/17 15:15	mg/L	CH70709
Total Nitrogen	**15.2** (2.02)		4500N		10	EEM	08/07/17 15:15	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH70722 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.44		mg/L	2.500		98	80-120			
Manganese	0.491		mg/L	0.5000		98	80-120			
Classical Chemistry										
Batch CH70432 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Batch CH70433 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							
Batch CH70708 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		99	80-120			
LCS										
Ammonia as N	1.19	0.10	mg/L	0.9994		119	80-120			
Batch CH70709 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH70709 - [CALC]										
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Kjeldahl Nitrogen as N	17.0	2.00	mg/L	14.20		120	80-120			
Total Nitrogen	17.0	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708129

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708129
Date Received: 8/4/2017
Project Due Date: 8/8/2017
Days for Project: 2 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 5.3 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	152606	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	152611	Yes	NA	Yes	1L Poly - H2SO4	NP	
02	152605	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	152610	Yes	NA	Yes	1L Poly - H2SO4	NP	
03	152604	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	152609	Yes	NA	Yes	1L Poly - H2SO4	NP	
04	152603	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	152608	Yes	NA	Yes	1L Poly - H2SO4	NP	
05	152602	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	152607	Yes	NA	Yes	1L Poly - H2SO4	NP	
05	152622	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 8/4/17 1726
Reviewed By: Date & Time: 8/4/17 1742
Delivered By: 8/4/17 1742

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1708129

Turn Time 48 Standard Other_____

Regulatory State (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name AECOM	Project # 60476644	Project Name Orleans Landfill	
Contact Person Mark Owen	Address 9 Jonathan Bourne Drive		
City Pocasset	State MA	Zip 02559	PO #
Tel. 978-204-0983	Fax.	email: mark.owen@aecom.com	

Analysis

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	NO2 NO3	Ammonia TKN	Diss Fe+Mn								
1	8-3-17	8:00 pm	G	H_2O	PW-1 (130-160)	1	1	P	250 ml	X										
1	8-3-17	8:00 PM	G	H_2O	PW-1 (130-160)	3	1	P	1000 ml		X									
2	8-4-17	12:00 AM	G	H_2O	PW-1 (130-160)	1	1	P	250ml	X										
2	8-4-17	12:00 AM	G	H_2O	PW-1 (130-160)	3	1	P	1000 m		X									
3	8-4-17	400 AM	G	H_2O	PW-1 (130-160)	1	1	P	250 ml	X										
3	8-4-17	400 AM	G	H_2O	PW-1 (130-160)	3	1	P	1000 ml		X									
4	8-4-17	700 AM	G	H_2O	PW-1 (130-160)	1	1	P	250 ml	X										
4	8-4-17	700 AM	G	H_2O	PW-1 (130-160)	3	1	P	1000 ml		X									
5	8-4-17	955 AM	G	H_2O	PW1 (130-160)	1	1	P	250 ml	X		X								
5	8-4-17	955 AM	G	H_2O	PW1 (130-160)	3	1	P	1000 ml		X									

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ____Yes ____No Internal Use Only

Seals Intact ____ Yes ____No NA:___ [ ] Pickup

Cooler Temperature: 5.3 ICE ice [ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : SC added Diss Lab Filtered Fe+Mn

Comments: per m.o. on 8/4/17

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
	8/4/17 1600	8/4/17 1600	
8/4/17 1701	8/4/17 1716		

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708202

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 2:43 pm, Aug 16, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

SAMPLE RECEIPT

The following samples were received on August 08, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708202-01	MW-16D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-02	MW-16S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-03	MW-2 (140-150)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708202-04	MW-2 (124-131)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-16D
Date Sampled: 08/08/17 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**4.77** (0.100)		200.7		1	KJK	08/09/17 20:51	10	10	CH70919
Manganese	**3.26** (0.020)		200.7		1	KJK	08/09/17 20:51	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-16D
Date Sampled: 08/08/17 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.39** (0.20)		350.1		2	JLK	08/10/17 18:06	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:29	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:46	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**9.09** (0.40)		351.2		2	JLK	08/11/17 19:49	mg/L	CH71005
Total Nitrogen	**9.09** (0.42)		4500N		2	JLK	08/11/17 19:49	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-16S
Date Sampled: 08/08/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**2.32** (0.100)		200.7		1	KJK	08/09/17 20:55	10	10	CH70919
Manganese	**1.72** (0.020)		200.7		1	KJK	08/09/17 20:55	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-16S
Date Sampled: 08/08/17 10:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**10.3** (0.50)		350.1		5	JLK	08/10/17 18:06	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:49	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**12.3** (1.00)		351.2		5	JLK	08/11/17 19:50	mg/L	CH71005
Total Nitrogen	**12.3** (1.02)		4500N		5	JLK	08/11/17 19:50	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 08/08/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	08/09/17 20:59	10	10	CH70919
Manganese	**4.59** (0.020)		200.7		1	KJK	08/09/17 20:59	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (140-150)
Date Sampled: 08/08/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**11.0** (0.50)		350.1		5	JLK	08/10/17 18:14	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 18:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:50	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**12.5** (1.00)		351.2		5	JLK	08/11/17 19:51	mg/L	CH71005
Total Nitrogen	**12.5** (1.02)		4500N		5	JLK	08/11/17 19:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (124-131)
Date Sampled: 08/08/17 16:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.148** (0.100)		200.7		1	KJK	08/09/17 21:04	10	10	CH70919
Manganese	**4.62** (0.020)		200.7		1	KJK	08/09/17 21:04	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (124-131)
Date Sampled: 08/08/17 16:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708202
ESS Laboratory Sample ID: 1708202-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**10.9** (0.50)		350.1		5	JLK	08/10/17 18:15	mg/L	CH70905
Nitrate as N	**0.154** (0.030)		353.2		1	JLK	08/09/17 18:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 17:51	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**13.1** (1.00)		351.2		5	JLK	08/11/17 19:51	mg/L	CH71005
Total Nitrogen	**13.2** (1.02)		4500N		5	JLK	08/11/17 19:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH70919 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.47		mg/L	2.500		99	80-120			
Manganese	0.489		mg/L	0.5000		98	80-120			
Classical Chemistry										
Batch CH70905 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
LCS										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			
Batch CH70924 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Batch CH70925 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							
Batch CH71005 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH71005 - [CALC]										
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708202

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 108202

Turn Time ____ (Standard) Other____

Regulatory State: (MA) RI CT NH NJ NY ME Other____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other____

Reporting Limits - ____

Electonic Deliverables Excel Access PDF

Co. Name: MARK OWEN / AECOM	Project #: 60476644	Project Name: Orleans, MA	
Contact Person: Mark Owen	Address: Lot Hollow Rd,		
City: Pocasset	State: MA	Zip: 02559	PO #:
Tel.: 508 833 6950	Fax: 508 833 6951	email: mark.owen@aecom.com	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: Total Nitrogen	TKN	Ammonia Nitrogen	Nitrate nitrogen	Nitrite nitrogen	Dissolved Fe/Mn
1	08/08/17	0945	G	GW	MW-16D	3	3	P	~~500ML~~	X	X	X	X	X	X
2	08/08/17	1045	G	GW	MW-16S	3	3	P		X	X	X	X	X	X
3	08/08/17	1530	G	GW	MW-2 (140-150)	3	3	P		X	X	X	X	X	X
4	08/08/17	1635	G	GW	MW-2 (124-131)	3	3	P		X	X	X	X	X	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile ~~V-VOA~~

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ____ Yes ____ No

Seals Intact ____ Yes ____ No NA: N

Cooler Temperature: 5.5 ICE

Internal Use Only
[ ] Pickup
[ ] Technician

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-____

Sampled by: ERIKA AMIR-LIN

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
8/8/17 1850	8/8/17 1700	8/8/17 1743	8/8/17 1850
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708238

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:14 pm, Aug 17, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

SAMPLE RECEIPT

The following samples were received on August 09, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708238-01	MW-6 (88-98)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-02	MW-7 (90-100)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-03	MW-7 (115-125)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-04	MW-13 (117-127)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-05	MW-13 (74-84)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-06	MW-8 (84-94)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708238-07	MW-9 (92-102)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 08/09/17 09:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**16.6** (0.100)		200.7		1	BJV	08/11/17 3:27	10	10	CH71031
Manganese	**1.95** (0.020)		200.7		1	BJV	08/11/17 3:27	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-6 (88-98)
Date Sampled: 08/09/17 09:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**24.5** (1.00)		350.1		10	JLK	08/10/17 18:16	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:35	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:42	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**26.0** (2.00)		351.2		10	JLK	08/11/17 19:52	mg/L	CH71005
Total Nitrogen	**26.0** (2.02)		4500N		10	JLK	08/11/17 19:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 08/09/17 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**9.30** (0.100)		200.7		1	BJV	08/11/17 3:44	10	10	CH71031
Manganese	**0.749** (0.020)		200.7		1	BJV	08/11/17 3:44	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (90-100)
Date Sampled: 08/09/17 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.12** (0.10)		350.1		1	JLK	08/10/17 17:44	mg/L	CH70905
Nitrate as N	**3.04** (0.110)		353.2		5	JLK	08/09/17 21:54	mg/L	[CALC]
Nitrite as N	**0.032** (0.010)		353.2		1	JLK	08/09/17 20:43	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**0.93** (0.20)		351.2		1	JLK	08/11/17 19:03	mg/L	CH71005
Total Nitrogen	**4.00** (0.30)		4500N		5	JLK	08/11/17 19:03	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (115-125)
Date Sampled: 08/09/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**17.0** (0.100)		200.7		1	BJV	08/11/17 3:48	10	10	CH71031
Manganese	**2.40** (0.020)		200.7		1	BJV	08/11/17 3:48	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-7 (115-125)
Date Sampled: 08/09/17 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**2.01** (0.10)		350.1		1	JLK	08/10/17 17:47	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:37	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:44	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**2.65** (0.20)		351.2		1	JLK	08/11/17 19:04	mg/L	CH71005
Total Nitrogen	**2.65** (0.22)		4500N		1	JLK	08/11/17 19:04	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-13 (117-127)
Date Sampled: 08/09/17 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/11/17 3:52	10	10	CH71031
Manganese	**0.131** (0.020)		200.7		1	BJV	08/11/17 3:52	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-13 (117-127)
Date Sampled: 08/09/17 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	08/10/17 17:48	mg/L	CH70905
Nitrate as N	**1.45** (0.110)		353.2		5	JLK	08/09/17 21:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:45	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**0.45** (0.20)		351.2		1	JLK	08/11/17 19:05	mg/L	CH71005
Total Nitrogen	**1.90** (0.30)		4500N		5	JLK	08/11/17 19:05	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-13 (74-84)
Date Sampled: 08/09/17 14:05
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**4.10** (0.100)		200.7		1	BJV	08/11/17 3:56	10	10	CH71031
Manganese	**0.163** (0.020)		200.7		1	BJV	08/11/17 3:56	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-13 (74-84)
Date Sampled: 08/09/17 14:05
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	08/10/17 17:56	mg/L	CH70905
Nitrate as N	**1.48** (0.110)		353.2		5	JLK	08/09/17 21:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:45	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**0.56** (0.20)		351.2		1	JLK	08/11/17 19:05	mg/L	CH71005
Total Nitrogen	**2.04** (0.30)		4500N		5	JLK	08/11/17 19:05	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (84-94)
Date Sampled: 08/09/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/11/17 4:13	10	10	CH71031
Manganese	**0.104** (0.020)		200.7		1	BJV	08/11/17 4:13	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-8 (84-94)
Date Sampled: 08/09/17 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	08/10/17 17:57	mg/L	CH70905
Nitrate as N	**11.5** (0.410)		353.2		20	JLK	08/09/17 21:56	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:46	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**1.91** (0.20)		351.2		1	JLK	08/11/17 19:06	mg/L	CH71005
Total Nitrogen	**13.4** (0.60)		4500N		20	JLK	08/11/17 19:06	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 08/09/17 16:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/11/17 4:17	10	10	CH71031
Manganese	**0.031** (0.020)		200.7		1	BJV	08/11/17 4:17	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-9 (92-102)
Date Sampled: 08/09/17 16:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708238
ESS Laboratory Sample ID: 1708238-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	JLK	08/10/17 17:58	mg/L	CH70905
Nitrate as N	**5.66** (0.210)		353.2		10	JLK	08/09/17 21:57	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:47	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**1.03** (0.20)		351.2		1	JLK	08/11/17 19:07	mg/L	CH71005
Total Nitrogen	**6.69** (0.40)		4500N		10	JLK	08/11/17 19:07	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH71031 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.38		mg/L	2.500		95	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch CH70905 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
LCS										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			
Batch CH70924 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Batch CH70925 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							
Batch CH71005 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH71005 - [CALC]										
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708238

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708238
Date Received: 8/9/2017
Project Due Date: 8/17/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.4 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / (NA)

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: _____ Time: _____ By: _____
    b. Low Level VOA vials frozen: Date: _____ Time: _____ By: _____

Sample Receiving Notes:
No project name @ 8/9/17

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? _____ Date: _____ Time: _____ By: _____

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	153591	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	153604	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	153605	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153590	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	153602	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153603	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153589	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	153600	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153601	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153588	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	153598	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153599	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	153613	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
05	153618	Yes	NA	Yes	250 mL Poly - Unpres	NP	
05	153619	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	153612	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
06	153616	Yes	NA	Yes	250 mL Poly - Unpres	NP	
06	153617	Yes	NA	Yes	250 mL Poly - Unpres	NP	
07	153611	Yes	NA	Yes	1L Amber - H2SO4	H2SO4	
07	153614	Yes	NA	Yes	250 mL Poly - Unpres	NP	
07	153615	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

ESS Project ID: 1708238
Date Received: 8/9/2017

Are barcode labels on correct containers? Yes / No

Completed By: _____ Date & Time: 8/9/17 1957

Reviewed By: _____ Date & Time: 8/9/17 2016

Delivered By: _____ 8/9/17 2016

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 108238

Turn Time: 5-Day Rush
Regulatory State
Is this project for any of the following?: ○CT RCP ○MA MCP ○RGP
Reporting Limits
Electonic Deliverables: ☐Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name: AECOM
Project #: 60476644
Project Name: ORLEANS mkm 8/10/17
Contact Person: Julianne Mamone
Address: 250 Apollo Drive
City: Chelmsford
State: MA
Zip Code:
PO #:
Telephone Number: 978-905-2419
FAX Number:
Email Address: Julianne.Mamone@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: TN, TKN, Ammonia	NO_2+NO_3	Diss. Fe, Mn
1	08/09/17	0925	G	GW	MW-6(88-98)	X	X	X
2	08/09/17	1020	G	GW	MW-7(90-100	X	X	X
3	08/09/17	1100	G	GW	MW-7(115-125)	X	X	X
4	08/09/17	1235	G	GW	MW-13(117-127)	X	X	X
5	08/09/17	1405	G	GW	MW-13(74-84)	X	X	X
6	08/09/17	1515	G	GW	MW-8(84-94)	X	X	X
7	08/09/17	1625	G	GW	MW-9(92-102)	X	X	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial — P P P
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other* — 6 3 3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other* — 3 1 1
Number of Containers per Sample: 1 1 1

Laboratory Use Only
Cooler Present: ✓
Seals Intact: NA
Cooler Temperature: 0.1-2.4°C Tracy

Sampled by: BKM
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
08/09/17 1705	8/9/17 17:05	8/9/17 19:26	8/9/17 1945
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708239

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 2:07 pm, Aug 17, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

SAMPLE RECEIPT

The following samples were received on August 09, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708239-01	MW-2S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-02	MW-2 (160-170)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-03	MW-2 (236-246)	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708239-04	MW-2 (236-246) DUP	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S
Date Sampled: 08/09/17 08:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/10/17 23:38	10	10	CH70919
Manganese	**0.514** (0.020)		200.7		1	BJV	08/10/17 23:38	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2S
Date Sampled: 08/09/17 08:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.11** (0.10)		350.1		1	JLK	08/10/17 17:58	mg/L	CH70905
Nitrate as N	**16.6** (0.410)		353.2		20	JLK	08/09/17 21:58	mg/L	[CALC]
Nitrite as N	**0.025** (0.010)		353.2		1	JLK	08/09/17 20:48	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**2.02** (0.20)		351.2		1	JLK	08/11/17 19:08	mg/L	CH71005
Total Nitrogen	**18.7** (0.60)		4500N		20	JLK	08/11/17 19:08	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 08/09/17 09:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**1.15** (0.100)		200.7		1	BJV	08/10/17 23:43	10	10	CH70919
Manganese	**6.72** (0.020)		200.7		1	BJV	08/10/17 23:43	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (160-170)
Date Sampled: 08/09/17 09:35
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**13.2** (0.50)		350.1		5	JLK	08/10/17 18:17	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:43	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:49	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**17.1** (2.00)		351.2		10	JLK	08/11/17 19:53	mg/L	CH71005
Total Nitrogen	**17.1** (2.02)		4500N		10	JLK	08/11/17 19:53	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (236-246)
Date Sampled: 08/09/17 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**10.6** (0.100)		200.7		1	BJV	08/10/17 23:47	10	10	CH70919
Manganese	**4.97** (0.020)		200.7		1	BJV	08/10/17 23:47	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (236-246)
Date Sampled: 08/09/17 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.52** (0.10)		350.1		1	JLK	08/10/17 18:00	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:44	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:50	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**5.23** (0.40)		351.2		2	JLK	08/11/17 19:54	mg/L	CH71005
Total Nitrogen	**5.23** (0.42)		4500N		2	JLK	08/11/17 19:54	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (236-246) DUP
Date Sampled: 08/09/17 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**10.6** (0.100)		200.7		1	BJV	08/10/17 23:51	10	10	CH70919
Manganese	**5.00** (0.020)		200.7		1	BJV	08/10/17 23:51	10	10	CH70919

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-2 (236-246) DUP
Date Sampled: 08/09/17 16:45
Percent Solids: N/A

ESS Laboratory Work Order: 1708239
ESS Laboratory Sample ID: 1708239-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.77** (0.10)		350.1		1	JLK	08/10/17 18:01	mg/L	CH70905
Nitrate as N	ND (0.030)		353.2		1	JLK	08/09/17 21:49	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/09/17 20:56	mg/L	CH70924
Total Kjeldahl Nitrogen as N	**5.54** (0.40)		351.2		2	JLK	08/11/17 19:54	mg/L	CH71005
Total Nitrogen	**5.54** (0.42)		4500N		2	JLK	08/11/17 19:54	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH70919 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.47		mg/L	2.500		99	80-120			
Manganese	0.489		mg/L	0.5000		98	80-120			
Classical Chemistry										
Batch CH70905 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		111	80-120			
LCS										
Ammonia as N	0.96	0.10	mg/L	0.9994		96	80-120			
Batch CH70924 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Nitrite as N	0.262		mg/L	0.2497		105	90-110			
Batch CH70925 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.492		mg/L							
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.492		mg/L	0.5000		98	90-110			
Total Nitrogen	0.492		mg/L							
Batch CH71005 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH71005 - [CALC]										
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Kjeldahl Nitrogen as N	15.7	2.00	mg/L	14.20		110	80-120			
Total Nitrogen	15.7	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708239

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM - ~~Earth Tech~~ Environment - ENSR - KPB/MM (8/9/17)

Shipped/Delivered Via: ~~Client~~ ESS Courier

ESS Project ID: 1708239
Date Received: 8/9/2017
Project Due Date: 8/17/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.9 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	153623	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	153630	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	153631	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153622	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	153628	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	153629	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153621	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	153626	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	153627	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153620	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
04	153624	Yes	NA	Yes	250 mL Poly - Unpres	NP	
04	153625	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? Yes / No

Completed By: Date & Time: 8/9/17 2006
Reviewed By: Date & Time: 8/9/17 2012
Delivered By: 8/9/17 2012

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 108239

Turn Time ____ (Standard) Other____

Regulatory State: (MA) RI CT NH NJ NY ME Other____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other____

Reporting Limits - ____

Electonic Deliverables Excel Access PDF

Co. Name: AECOM	Project #: 60476644	Project Name: Orleans, MA	
Contact Person: MARK OWEN	Address: 9 Jonathan Bourne Dr.		
City: Pocasset	State: MA	Zip: 02559	PO #:
Tel: 508-833-6950	Fax: 508-833-6951	email: mark.owen@aecom.com	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: Total nitrogen	Ammonia Nitrogen	TKN	Nitrate Nitrogen	Nitrite Nitrogen	Dissolved Fe/Mn
1	08/09/17	0825	G	GW	MW-25	3	3	P		X	X	X	X	X	X
2	08/09/17	0935	G	GW	MW-2(160-170)	3	3	P		X	X	X	X	X	X
3	08/09/17	1645	G	GW	MW-2(236-246)	3	3	P		X	X	X	X	X	X
4	08/09/17	1645	G	GW	MW-2(236-246)DUP	3	3	P		X	X	X	X	X	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA: ____

Cooler Temperature: 0.7+2.9 Tue

Internal Use Only
[V] Pickup
[ ] Technician____

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-____

Sampled by: ERIKA Amir-Lin

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
08/09/17 1700	8/9/17 17:05	8/9/17 19:26	8/9/17 1945
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708290

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 7:15 pm, Aug 18, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

SAMPLE RECEIPT

The following samples were received on August 10, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708290-01	MW-5S	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708290-02	MW-5	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5S
Date Sampled: 08/10/17 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 1708290
ESS Laboratory Sample ID: 1708290-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	08/11/17 11:15	10	10	CH71031
Manganese	**0.053** (0.020)		200.7		1	KJK	08/11/17 11:15	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5S
Date Sampled: 08/10/17 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 1708290
ESS Laboratory Sample ID: 1708290-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	ND (0.10)		350.1		1	EEM	08/15/17 14:55	mg/L	CH71110
Nitrate as N	**9.54** (0.410)		353.2		20	JLK	08/11/17 21:26	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/11/17 20:27	mg/L	CH71130
Total Kjeldahl Nitrogen as N	**2.06** (0.20)		351.2		1	EEM	08/17/17 15:23	mg/L	CH71602
Total Nitrogen	**11.6** (0.600)		4500N		20	EEM	08/17/17 15:23	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5
Date Sampled: 08/10/17 12:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708290
ESS Laboratory Sample ID: 1708290-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.120** (0.100)		200.7		1	KJK	08/11/17 11:31	10	10	CH71031
Manganese	**1.39** (0.020)		200.7		1	KJK	08/11/17 11:31	10	10	CH71031

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5
Date Sampled: 08/10/17 12:15
Percent Solids: N/A

ESS Laboratory Work Order: 1708290
ESS Laboratory Sample ID: 1708290-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**9.40** (0.20)		350.1		2	EEM	08/15/17 15:07	mg/L	CH71110
Nitrate as N	ND (0.030)		353.2		1	JLK	08/11/17 21:15	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/11/17 20:28	mg/L	CH71130
Total Kjeldahl Nitrogen as N	**10.4** (2.00)		351.2		10	EEM	08/17/17 15:36	mg/L	CH71602
Total Nitrogen	**10.4** (2.02)		4500N		10	EEM	08/17/17 15:36	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH71031 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.38		mg/L	2.500		95	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch CH71110 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.11	0.10	mg/L	0.09994		114	80-120			
LCS										
Ammonia as N	0.95	0.10	mg/L	0.9994		95	80-120			
Batch CH71130 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.256		mg/L	0.2497		102	90-110			
Nitrite as N	0.256		mg/L	0.2497		102	90-110			
Batch CH71131 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.496		mg/L							
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Total Nitrogen	0.496		mg/L							
Batch CH71602 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH71602 - [CALC]										
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Nitrogen	16.7	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708290

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1708290

Turn Time _____Standard Other_____

Regulatory State: MA RI CT NH NJ NY ME Other_____

Reporting Limits - _____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Electonic Deliverables Excel Access PDF

Co. Name: Mark Owens | AECOM
Project #: 60476644
Project Name: Orleans, MA
Contact Person: mark owen
Address: 9 Jonathan Bourne Dr.
City: Pocasset
State: MA
Zip: 02559
PO #:
Tel.: ~~617~~ 508-833-6964
Fax: 508-833-6951
email: mark.owen@aecom.com

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: Total Nitrogen	Ammonia Nitrogen	TKN	Nitrate	Nitrite	Dissolved Fe/Mn				
1	08/10/17	1055	G	GW	MW-55	3	3	P	1L 250 mL	X	X	X	X	X	X				
2	08/10/17	1215	G	GW	MW-5	3	3	P	1L 250 mL	X	X	X	X	X	X				

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes _____No

Seals Intact ____ Yes _____No NA: ✓

Cooler Temperature: 4.2°Ice

Internal Use Only
[X] Pickup
[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : ERIKA AMIR-LIN

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
08/10/17 1645	8-10-17 1645	8-10-17 1845	8/10/17 1901
Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708336

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

SAMPLE RECEIPT

The following samples were received on August 15, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708336-01	MW-5D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708336-02	MW-3D	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708336-03	MW-14	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5D
Date Sampled: 08/14/17 11:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.820** (0.100)		200.7		1	KJK	08/15/17 12:04	10	10	CH71523
Manganese	**0.664** (0.020)		200.7		1	KJK	08/15/17 12:04	10	10	CH71523

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-5D
Date Sampled: 08/14/17 11:25
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**13.7** (0.50)		350.1		5	JLK	08/17/17 17:28	mg/L	CH71614
Nitrate as N	ND (0.030)		353.2		1	JLK	08/15/17 21:20	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/15/17 20:31	mg/L	CH71537
Total Kjeldahl Nitrogen as N	**16.4** (2.00)		351.2		10	EEM	08/17/17 15:38	mg/L	CH71602
Total Nitrogen	**16.4** (2.02)		4500N		10	EEM	08/17/17 15:38	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3D
Date Sampled: 08/14/17 13:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**33.7** (0.100)		200.7		1	KJK	08/15/17 12:08	10	10	CH71523
Manganese	**2.42** (0.020)		200.7		1	KJK	08/15/17 12:08	10	10	CH71523

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-3D
Date Sampled: 08/14/17 13:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**3.83** (0.10)		350.1		1	JLK	08/17/17 17:18	mg/L	CH71614
Nitrate as N	ND (0.030)		353.2		1	JLK	08/15/17 21:22	mg/L	[CALC]
Nitrite as N	**0.015** (0.010)		353.2		1	JLK	08/15/17 20:34	mg/L	CH71537
Total Kjeldahl Nitrogen as N	**5.26** (0.40)		351.2		2	EEM	08/17/17 15:39	mg/L	CH71602
Total Nitrogen	**5.26** (0.42)		4500N		2	EEM	08/17/17 15:39	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-14
Date Sampled: 08/14/17 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	08/15/17 12:13	10	10	CH71523
Manganese	**0.050** (0.020)		200.7		1	KJK	08/15/17 12:13	10	10	CH71523

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-14
Date Sampled: 08/14/17 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 1708336
ESS Laboratory Sample ID: 1708336-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**0.16** (0.10)		350.1		1	JLK	08/17/17 17:19	mg/L	CH71614
Nitrate as N	**8.44** (0.410)		353.2		20	JLK	08/15/17 21:37	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/15/17 20:35	mg/L	CH71537
Total Kjeldahl Nitrogen as N	**1.11** (0.20)		351.2		1	EEM	08/17/17 15:35	mg/L	CH71602
Total Nitrogen	**9.56** (0.60)		4500N		20	EEM	08/17/17 15:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH71523 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.41		mg/L	2.500		96	80-120			
Manganese	0.485		mg/L	0.5000		97	80-120			
Classical Chemistry										
Batch CH71537 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Nitrite as N	0.258		mg/L	0.2497		103	90-110			
Batch CH71538 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.477		mg/L							
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Nitrate/Nitrite as N	0.477		mg/L	0.5000		95	90-110			
Total Nitrogen	0.477		mg/L							
Batch CH71602 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Kjeldahl Nitrogen as N	16.7	2.00	mg/L	14.20		118	80-120			
Total Nitrogen	16.7	2.00	mg/L							
Batch CH71614 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.08	0.10	mg/L	0.09994		82	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH71614 - NH4 Prep										
LCS										
Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708336
Date Received: 8/14/2017
Project Due Date: 8/21/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.2 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / ~~No~~
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	154650	Yes	NA	Yes	1L Poly - H2SO4	NP	
01	154655	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	154656	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	154649	Yes	NA	Yes	1L Poly - H2SO4	NP	
02	154653	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	154654	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	154648	Yes	NA	Yes	1L Poly - H2SO4	NP	
03	154651	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	154652	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 8/15/17 0824
Reviewed By: Date & Time: 8/15/17 0838
Delivered By: 8/15/17 0838

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1708336

Turn Time ____ (Standard) Other____

Regulatory State: (MA) RI CT NH NJ NY ME Other____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other____

Reporting Limits - ____

Electonic Deliverables Excel Access PDF

Co. Name: AECOM	Project #: 60476644	Project Name: Orleans, MA	
Contact Person: Mark Owen	Address: 9 Jonathan Bourne Dr.		
City: Pocasset	State: MA	Zip: 02559	PO #
Tel: 508-833-6964	Fax: 508-833-6951	email: Mark.owen@aecom.com	

Analysis: Total Nitrogen Ammonia, TKN | Nitrate | Dissolved Fe/Mn

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Total Nitrogen Ammonia, TKN	Nitrate	Dissolved Fe/Mn
1	08/14/17	1125	G	GW	MW-5D	3	3	P	1L 250mL	X	X	X
2	08/14/17	1320	G	GW	MW-3D	3	3	P	1L 250mL	X	X	X
3	08/14/17	1420	G	GW	MW-14	3	3	P	1L 250mL	X	X	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No Internal Use Only

Seals Intact ____ Yes ____ No NA: ✓

Cooler Temperature: Iced w/ 2 @ 8/14/17 17:24

[ ] Pickup

[ ] Technician____

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-____

Sampled by: Erika Amie-Lin

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
08/14/17 - 1530	8/14/17 15:30	8/14/17 17:24	Fedex 8/14/17 17:24
Fedex 8/15/17 0823	8/15/17 0823		

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

Items for Project Management Review

Classical Chemistry
Dissolved Metals

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708336

PROJECT COMPLETION CHECKLIST

All Reports:

1. Has Report been Paginated?	Yes	No	
2. Has Report been Digitally Signed?	Yes	No	
3. Has MCP/RPC Sheet been filled out?	Yes	No	N/A
4. Have PRM and Fax Sheet been removed from the Project?	Yes	No	
5. Is the correct Chain of Custody attached to the Report?	Yes	No	
6. Is the correct Cooler Receipt attached to the Report?	Yes	No	N/A

Contact Person: _____ EDD:_____

E-Mail: _____

1. Does e-mail address in Element match the COC/CSR?	Yes	No	
1a. If No, did you contact Customer Service?	Yes	No	N/A
2. Are their any CCs for the report?	Yes	No	
3a If Yes, did you include them?	Yes	No	N/A
4. Did you save a copy of the e-mail in the Work Order Folder?	Yes	No	

Client Connect: _____

1. Did you save Report in CORRECT ClientConnect Folder?	Yes	No	N/A
2. Did you save EDD in CORRECT ClientConnect Folder?	Yes	No	N/A

Fax:_____

1. Does fax number in Element match the COC?	Yes	No	
1a. Did you contact Customer Service?	Yes	No	N/A
2. Was the fax "rejected" for any reason?	Yes	No	
2a. Was the project re-faxed?	Yes	No	N/A
2b. Was Customer Service notified?	Yes	No	N/A

Updated to Faxed: Yes No N/A Initials:_____ Date:_____

ESS Laboratory

Division of Thielsch Engineering, Inc.

FAX

Date: _____

To: Mark Owen

Company: AECOM Environment - ENSR

Project Name: Orleans MA

ESS Work Order: 1708336

Fax: (978) 589-3100

Comments:

Our certified laboratory provides a full range of services, including the following:

- -Soil Characterization
- -Petroleum Fingerprinting
- -Priority Pollutant Analysis
- -Groundwater, Wastewater and Drinking Water Analyses
- -PCBs and Pesticides Analysis
- -Trace Metals (ICAP/Furnace) Analysis
- -Inorganic Analysis by Classic Methods, Flow Analyzer, and Ion Chromatography
- -Organics by GC/Mass Spectroscopy
- -Microbiology Analysis
- -Massachusetts EPH/VPH Analysis
- -Siloxanes
- -Field Screening and Sample Technician Services

This message is meant for the use of the individual or entity to which it is addressed. This fax may contain privileged or confidential information that is intended for the recipient only. Any copying or unauthorized distribution of the enclosed information is prohibited. If you have received this communication incorrectly, please notify us immediately. Thank you for your cooperation

Number of pages (including this cover): _____

Date: _____ Faxed: ____ Initials: _____ Time: _____

185 Frances Avenue, Cranston, RI 02910-2211 Tel: 401-461-7181 Fax: 401-461-4486 http://www.ESSLaboratory.com

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708433

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:48 pm, Aug 24, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

SAMPLE RECEIPT

The following samples were received on August 17, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708433-01	PW-2S-2Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708433-02	PW-2S-4Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708433-03	PW-2S-7.5Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-2Hr
Date Sampled: 08/17/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/21/17 15:34	10	10	CH71723
Manganese	**4.20** (0.020)		200.7		1	KJK	08/18/17 14:06	10	10	CH71723

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-2Hr
Date Sampled: 08/17/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.37** (0.20)		350.1		2	JLK	08/22/17 21:40	mg/L	CH72115
Nitrate as N	**0.412** (0.030)		353.2		1	JLK	08/17/17 22:17	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:13	mg/L	CH71740
Total Kjeldahl Nitrogen as N	**10.2** (2.00)		351.2		10	EEM	08/21/17 15:59	mg/L	CH71806
Total Nitrogen	**10.6** (2.02)		4500N		10	EEM	08/21/17 15:59	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-4Hr
Date Sampled: 08/17/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/21/17 15:38	10	10	CH71723
Manganese	**4.17** (0.020)		200.7		1	KJK	08/18/17 14:11	10	10	CH71723

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-4Hr
Date Sampled: 08/17/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**7.11** (0.20)		350.1		2	JLK	08/22/17 21:42	mg/L	CH72115
Nitrate as N	**0.519** (0.030)		353.2		1	JLK	08/17/17 22:18	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:13	mg/L	CH71740
Total Kjeldahl Nitrogen as N	**8.87** (2.00)		351.2		10	EEM	08/21/17 16:00	mg/L	CH71806
Total Nitrogen	**9.39** (2.02)		4500N		10	EEM	08/21/17 16:00	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-7.5Hr
Date Sampled: 08/17/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	BJV	08/21/17 15:43	10	10	CH71723
Manganese	**4.00** (0.020)		200.7		1	KJK	08/18/17 14:15	10	10	CH71723

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2S-7.5Hr
Date Sampled: 08/17/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708433
ESS Laboratory Sample ID: 1708433-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**6.74** (0.20)		350.1		2	JLK	08/22/17 21:43	mg/L	CH72115
Nitrate as N	**0.626** (0.030)		353.2		1	JLK	08/17/17 22:19	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/17/17 21:14	mg/L	CH71740
Total Kjeldahl Nitrogen as N	**8.62** (2.00)		351.2		10	EEM	08/21/17 16:01	mg/L	CH71806
Total Nitrogen	**9.25** (2.02)		4500N		10	EEM	08/21/17 16:01	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH71723 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.51		mg/L	2.500		101	80-120			
Manganese	0.497		mg/L	0.5000		99	80-120			
Classical Chemistry										
Batch CH71740 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.252		mg/L	0.2497		101	90-110			
Nitrite as N	0.252		mg/L	0.2497		101	90-110			
Batch CH71741 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.02	mg/L							
LCS										
Nitrate as N	0.472		mg/L							
Nitrate/Nitrite as N	0.472		mg/L	0.5000		94	90-110			
Nitrate/Nitrite as N	0.472		mg/L	0.5000		94	90-110			
Total Nitrogen	0.472		mg/L							
Batch CH71806 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	16.0	2.00	mg/L	14.20		113	80-120			
Total Kjeldahl Nitrogen as N	16.0	2.00	mg/L	14.20		113	80-120			
Total Nitrogen	16.0	2.00	mg/L							
Batch CH72115 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH72115 - NH4 Prep										
LCS										
Ammonia as N	0.12	0.10	mg/L	0.09994		117	80-120			
LCS										
Ammonia as N	0.99	0.10	mg/L	0.9994		99	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708433

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708433
Date Received: 8/17/2017
Project Due Date: 8/24/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.5 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? (Yes) / No
    a. Air bubbles in aqueous VOAs? Yes / (No)
    b. Does methanol cover soil completely? Yes / No / (NA)
13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	155482	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	155487	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	155488	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	155481	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	155485	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	155486	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	155480	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
03	155483	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	155484	Yes	NA	Yes	250 mL Poly - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 8/17/17 1843
Reviewed By: Date & Time: 8/17/17 1948
Delivered By: 8/17/17 1948

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 708433

Turn Time: 5-Day Rush
Regulatory State
Is this project for any of the following?: ○CT RCP ○MA MCP ○RGP
Reporting Limits
Electonic Deliverables: ☐Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM		Orleans, MA
Contact Person		**Address**
Mark Owen		9 Jonathan Bourne Drive
City	**State**	**Zip Code** / **PO #**
Pocasset	MA	02559
Telephone Number	**FAX Number**	**Email Address**
508-833-6964	508-833-6951	mark.owen@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen, TKN, Ammonia	Nitrate / Nitrite	Dissolved Fe, Mn
1	08/17/17	1000	G	GW	PW-2S-2hr	X	X	X
2	08/17/17	1200	G	GW	PW-2S-4hr	X	X	X
3	08/17/17	1530	G	GW	PW-2S-7.5hr	X	X	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial — P P P
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other* — 6 3 3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other* — 3 1 1
Number of Containers per Sample: 1 1 1

Laboratory Use Only
Cooler Present:
Seals Intact: NA
Cooler Temperature: 4.0 °C Rem

Sampled by: Erika Amir-Lin
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
08/17/17 1600	8/17/17 1600	8/17/17 1824	8/17/17 1841
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Mark Owen
AECOM Environment - ENSR
9 Jonathon Bourne Dr.
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 1708620

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:19 pm, Aug 31, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

SAMPLE RECEIPT

The following samples were received on August 24, 2017 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
1708620-01	PW-2D-2Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708620-02	PW-2D-4Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N
1708620-03	PW-2D-7.5Hr	Ground Water	200.7, 350.1, 351.2, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-2Hr
Date Sampled: 08/24/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.306** (0.100)		200.7		1	KJK	08/25/17 21:20	10	10	CH72523
Manganese	**4.49** (0.020)		200.7		1	KJK	08/25/17 21:20	10	10	CH72523

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-2Hr
Date Sampled: 08/24/17 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.89** (0.10)		350.1		1	JLK	08/29/17 17:58	mg/L	CH72907
Nitrate as N	**0.167** (0.030)		353.2		1	JLK	08/24/17 21:41	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:41	mg/L	CH72431
Total Kjeldahl Nitrogen as N	**6.47** (1.00)		351.2		5	JLK	08/30/17 17:55	mg/L	CH72908
Total Nitrogen	**6.64** (1.02)		4500N		5	JLK	08/30/17 17:55	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-4Hr
Date Sampled: 08/24/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.369** (0.100)		200.7		1	KJK	08/25/17 21:36	10	10	CH72523
Manganese	**4.47** (0.020)		200.7		1	KJK	08/25/17 21:36	10	10	CH72523

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-4Hr
Date Sampled: 08/24/17 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**5.08** (0.20)		350.1		2	JLK	08/29/17 18:20	mg/L	CH72907
Nitrate as N	**0.188** (0.030)		353.2		1	JLK	08/24/17 21:42	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:42	mg/L	CH72431
Total Kjeldahl Nitrogen as N	**5.77** (1.00)		351.2		5	JLK	08/30/17 17:57	mg/L	CH72908
Total Nitrogen	**5.96** (1.02)		4500N		5	JLK	08/30/17 17:57	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-7.5Hr
Date Sampled: 08/24/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.350** (0.100)		200.7		1	KJK	08/25/17 21:41	10	10	CH72523
Manganese	**4.38** (0.020)		200.7		1	KJK	08/25/17 21:41	10	10	CH72523

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: PW-2D-7.5Hr
Date Sampled: 08/24/17 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 1708620
ESS Laboratory Sample ID: 1708620-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Ammonia as N	**4.96** (0.10)		350.1		1	JLK	08/29/17 18:11	mg/L	CH72907
Nitrate as N	**0.186** (0.030)		353.2		1	JLK	08/24/17 21:43	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	08/24/17 21:43	mg/L	CH72431
Total Kjeldahl Nitrogen as N	**5.83** (1.00)		351.2		5	JLK	08/30/17 17:58	mg/L	CH72908
Total Nitrogen	**6.02** (1.02)		4500N		5	JLK	08/30/17 17:58	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch CH72523 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.48		mg/L	2.500		99	80-120			
Manganese	0.517		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch CH72431 - [CALC]										
Blank										
Nitrate as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrate as N	ND		mg/L							
Nitrite as N	0.263		mg/L	0.2497		105	90-110			
Nitrite as N	0.263		mg/L	0.2497		105	90-110			
Batch CH72432 - [CALC]										
Blank										
Nitrate as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
Total Nitrogen	ND	0.020	mg/L							
LCS										
Nitrate as N	0.464		mg/L							
Nitrate/Nitrite as N	0.464		mg/L	0.5000		93	90-110			
Nitrate/Nitrite as N	0.464		mg/L	0.5000		93	90-110			
Total Nitrogen	0.464		mg/L							
Batch CH72907 - NH4 Prep										
Blank										
Ammonia as N	ND	0.10	mg/L							
LCS										
Ammonia as N	0.10	0.10	mg/L	0.09994		103	80-120			
LCS										
Ammonia as N	1.02	0.10	mg/L	0.9994		102	80-120			
Batch CH72908 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
Total Nitrogen	ND	0.200	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	15.0	2.00	mg/L	14.20		105	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch CH72908 - TKN Prep										
Total Kjeldahl Nitrogen as N	15.0	2.00	mg/L	14.20		105	80-120			
Total Nitrogen	15.0	2.00	mg/L							

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 1708620

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1708620
Date Received: 8/24/2017
Project Due Date: 8/31/2017
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 1.0 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	157232	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
01	157235	Yes	NA	Yes	250 mL Poly - Unpres	NP	
01	157236	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	157231	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	
02	157233	Yes	NA	Yes	250 mL Poly - Unpres	NP	
02	157234	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157237	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157238	Yes	NA	Yes	250 mL Poly - Unpres	NP	
03	157239	Yes	NA	Yes	1L Poly - H2SO4	H2SO4	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 8/24/17 2005
Reviewed By: Date & Time: 8/24/17 2034
Delivered By: 8/24/17 2034

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 708620

Turn Time: 5-Day Rush
Regulatory State: MA
Is this project for any of the following?: ○CT RCP ○MA MCP ○RGP
Reporting Limits:
Electonic Deliverables: ☐Limit Checker ☐Standard Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM		Orleans, MA

Contact Person	Address
Mark Owen	5 Jonathan Bourne Drive

City	State	Zip Code	PO #
Pocasset	MA	02559	

Telephone Number	FAX Number	Email Address
508-833-6964	508-833-6951	mark.owen@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen, Ammonia, TKN	Nitrate / Nitrite	Dissolved Fe, Mn
1	08/24/17	1000	G	GW	PW-2D-2hr	X	X	X
2	08/24/17	1200	G	GW	PW-2D-4hr	X	X	X
3	08/24/17	1530	G	GW	PW-2D-7.5hr	X	X	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer G - Glass O-Other P-Poly S-Sterile V-Vial — P P P
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other* — 6 3 3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other* — 3 1 1
Number of Containers per Sample: 1 1 1

Laboratory Use Only
Cooler Present: ✓
Seals Intact: ✓
Cooler Temperature: Iced emp 1.5 °C 19:41 8/24/17

Sampled by: Erika Amir-Lin
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
08/24/17: 1845	8/24/17 18:45	19:41 8/24/17	8/24/17 1957
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

ATTACHMENT 4

Previous MEPA DECISIONS

ATTACHMENT 4a

2011 Certificate of the Secretary of Energy and Environmental Affairs of the Single Environmental Impact Report

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Deval L. Patrick
GOVERNOR

Timothy P. Murray
LIEUTENANT GOVERNOR

Richard K. Sullivan, Jr.
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

January 28, 2011

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
SINGLE ENVIRONMENTAL IMPACT REPORT

PROJECT NAME	: Town of Orleans Comprehensive Wastewater Management Plan
PROJECT MUNICIPALITY	: Town of Orleans
PROJECT WATERSHED	: Cape and Islands
EOEA NUMBER	: 14414
PROJECT PROPONENT	: Town of Orleans
DATE NOTICED IN MONITOR	: December 22, 2010

As Secretary of Energy and Environmental Affairs, I hereby determine that the Single Environmental Impact Report (SEIR) submitted on this project **adequately and properly complies** with the Massachusetts Environmental Policy Act (M.G.L. c. 30, ss. 61-62I) and with its implementing regulations (301 CMR 11.00).

The comments I have received on the SEIR from MassDEP, the Cape Cod Commission (CCC) and others indicate that since the Secretary's issuance of the Certificate on the Expanded Environmental Notification Form (EENF), the Town of Orleans (the Town) has worked closely with MassDEP and CCC to provide additional information to address the comments raised on the EENF pertaining to water quality monitoring at the Orleans Wastewater Treatment Facility (Orleans WWTF) site, the Town's Adaptive Management Plan (AMP) and the project's potential impacts to coastal resource areas. I commend the Town on its continued coordination and outreach efforts in this regard. As a consequence of these efforts, MassDEP, CCC, the Pleasant Bay Resource Management Alliance and others have indicated their strong support for the Town's Comprehensive Wastewater Management Plan (CWMP).

I have received a number of comments on the SEIR that express continuing concerns regarding the Town's proposed centralized sewer system design, potential impacts to the

Namskaket Marsh embayment from the groundwater discharge at the Tri-Town site, and the Total Maximum Daily Loads (TMDLs) established for the coastal embayments surrounding the Town of Orleans.

I have fully considered all of the comments received on the EENF and the SEIR and, on balance, I am convinced that the Town has satisfactorily evaluated the project's potential environmental impacts and committed to an appropriate package of mitigation commitments. While I acknowledge the remaining concerns of a number of residents from the Town of Orleans and neighboring Cape Cod communities, I am confident that these concerns can be adequately addressed during the state and local permitting process and through the implementation of the Town's Adaptive Management Plan. Towards that end, I am directing the Town to continue the same high-level of coordination and cooperation with state, regional and local officials that it has shown throughout the MEPA review process for this project as the project proceeds to permitting.

Thus, after careful review of the SEIR and comment letters, and after consultation with MassDEP, the Cape Cod Commission and others, I believe that the SEIR has addressed the substantive issues outlined in the scope and has demonstrated to MEPA's and the permitting agencies' satisfaction that the Town of Orleans has avoided, minimized, and mitigated impacts to the maximum extent feasible. The project may proceed to state permitting where I expect that MassDEP will continue to scrutinize potential project impacts and require additional mitigation where appropriate.

Project Overview

The Orleans CWMP calls for the phased construction of a new centralized municipal sewer system and implementation of non-structural program elements to achieve significant reductions of nitrogen loading and meet TMDL limits for the coastal embayments surrounding the Town of Orleans over a 20-year phased project construction period.

The Town of Orleans' CWMP includes:

- Orleans WWTF

  Constructing a new centralized wastewater treatment and disposal facility to be located at the existing 26-acre Tri-Town Septage Treatment facility site in Orleans capable of achieving effluent concentration limits of 3-5 mg/L for total nitrogen (TN) with an initial designed capacity to treat and dispose up to 0.64 million gallons per day (MGD) of wastewater flows;

- Core Program Sewers

  Constructing approximately 74 miles of new municipal sewer pipe, and approximately 63 sewer pump stations in 6 construction phases to collect and convey approximately 0.64 MGD of wastewater flows from 2,800 individual properties located in the Pleasant Bay, Nauset and Rock Harbor watersheds for treatment and on-site disposal at the Orleans WWTF;

- Non Structural Program Elements

  Implementing non-structural program elements to provide additonal reductions in nutrient loading within the embayments surrounding Orleans including: fertilizer use controls, stormwater management controls, water conservation measures and enhancement of embayment flushing;

- Adaptive Management Plan

  Employing an Adaptive Management Plan that establishes a process for identifying measurable reductions in nitrogen loading; compliance with TMDLs for the coastal embayments surrounding Orleans; and the need for any adjustments or mid-course revisions to the Orleans CWMP prior to constructing the later Core Program phases; and,

- Regional Wastewater Management Opportunities

  The Town's Final CWMP has been designed to also accommodate potential additional future wastewater flows from the neighboring towns of Eastham and/or Brewster (Regional Program).

MEPA Review History

In May 2009, the Town of Orleans (the Town), in accordance with Section 11.05(7) of the MEPA regulations, submitted an EENF with a request that the Secretary allow the Proponent to fulfill its EIR obligations under MEPA with a Single EIR, rather than the usual process of a Draft and Final EIR. The EENF received an extended comment period pursuant to Section 11.06(8) of the MEPA regulations and the Town voluntarily extended the comment period an additional four weeks. The EENF included clear descriptions of the project, a description of the extensive planning and alternatives analysis conducted to date, identified potential environmental impacts associated with the project and provided initial commitments to mitigate impacts. Comments received from MassDEP, the Cape Cod Commission (CCC) and others indicated overwhelming support for the analysis and conclusions included in the EENF and its consistency with legal

requirements. In July 2009, the Secretary issued a Certificate on the EENF and based on a review of the EENF and after consultation with state agencies, determined that the EENF met the regulatory requirements and permitted the Proponent to file a SEIR in fulfillment of Section 11.03 of the MEPA regulations.

State Permits and Jurisdiction

The project is undergoing review pursuant to Sections 11.03(5)(a)(3) and (5)(b)(1) of the MEPA regulations, because the project will likely involve the construction of sewer mains ten or more miles in length and the development of a new wastewater treatment facility with a capacity of more than 1,000,000 gallons per day. The project will require a Groundwater Discharge Permit, a Chapter 91 License, and a 401 Water Quality Certificate from MassDEP. The project must be reviewed by the Natural Heritage Endangered Species Program (NHESP) and the Massachusetts Historical Commission (MHC) because portions of the project occur within Priority Habitat and within or adjacent to recorded archaeological sites and archaeologically sensitive areas, respectively. The project may require a Conservation and Management Permit from NHESP. It may require Federal Consistency Review with the Massachusetts Coastal Zone Management (MCZM) Office. It may also require a Construction Access Permit from the Massachusetts Highway Department. The project may need to obtain a Section 404 Permit from the U.S. Army Corps of Engineers. The project should comply with the National Pollutant Discharge Elimination System (NPDES) General Permit for stormwater discharges from a construction site. It will also require an Order of Conditions from the Orleans Conservation Commission and on appeal only, a Superseding Order of Conditions from MassDEP.

The Town anticipates applying for State Revolving Fund (SRF) loans for subsequent planning and construction of proposed sewer project. Therefore, MEPA jurisdiction is broad and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

REVIEW OF THE SINGLE ENVIRONMENTAL IMAPCT REPORT and FINAL CWMP

Project Description

The SEIR includes a detailed discussion of the findings of the Massachusetts Estuaries Project (MEP) Technical Reports and/or TMDLs established for Pleasant Bay, Rock Harbor, Namskaket and Little Namskaket embayments used by the Town in the design of the Orleans

CWMP. The SEIR provides additional information to satisfactorily demonstrate that the Tri-Town site is an acceptable effluent recharge site that could accommodate the treatment and on-site discharge of the Core Program's estimated wastewater flows. The SEIR provides a detailed description of the Town's proposed Adaptive Management Plan and its water quality monitoring program for the Tri-Town site and the coastal embayments surrounding the Town of Orleans. The SEIR identifies significant environmental benefits and impacts, and measures that will be taken to avoid, minimize and mitigate the Core Program sewer project's unavoidable impacts to environmental resource areas. The SEIR includes a proposed schedule for completing the final design and environmental permitting for the Orleans CWMP and each phase of its sewer construction program. The SEIR includes additional information and maps identifying the areas in Orleans where construction of new sewers or cluster systems are proposed and the locations where sewer lines, pumping stations, and other facilities will be located.

Structural Program Elements

Core Sewer Program

The Town's core sewer construction plan (Core Program) involves the phased construction of new sewers to eliminate septic systems in areas of Orleans having the greatest need for nitrogen control and located upgradient of nitrogen sensitive watersheds and major freshwater ponds. As described in the SEIR, the Core program's sewer service area was designed to provide for the collection of as much wastewater nitrogen as necessary using the least amount of wastewater collection and conveyance infrastructure.

The Core Program includes the construction of a new centralized wastewater treatment facility (Orleans WWTF) to be located at the existing 26-acre Tri-Town Septage Treatment facility located near the intersection of Route 6 and Route 6A at 29 Overland Way in Orleans. The new Orleans WWTF is designed with an initial capacity to treat and dispose up to 0.64 MGD and will employ a 4-stage Bardenpho nitrogen removal process that will provide treatment levels capable of achieving nitrogen effluent concentrations of 3-5 milligrams per liter (mg/l) of total effluent Nitrogen (Level 2 nitrogen limits) and the removal of numerous pathogenic organisms. Under the Core Program, a total of approximately 74 miles of new municipal sewer pipe, and approximately 63 sewer pump stations will be constructed in 6 construction phases to collect and convey 2030 design year wastewater flows (approximately 0.64 MGD) from 2,800 individual properties (approximately 53% percent of the Town) located in the Pleasant Bay, Nauset and Rock Harbor watersheds for treatment and on-site disposal at the Orleans WWTF site. Construction of Phase 1 of the Core Program is expected to be completed in 2017 and will include the construction of the new Orleans WWTF (to operate at 50% design capacity) and approximately 15 miles of new sewers and 7 pump stations located primarily throughout the downtown area of Orleans.

Phase II of the Core Program will include the construction of approximately 11 miles of sewers and 10 pump stations. Phase 2 will also involve the construction of five separate below-ground cluster wastewater treatment systems with approximately 11 miles of additional gravity sewers and new pump stations to serve neighborhoods located in the watersheds of four impacted coastal embayments and one freshwater pond including the headwaters of the Paw Wah Pond, Lonnies Pond, Arey's Pond, Mill Pond and Baker's Pond, respectively. As described in the SEIR, these cluster systems will provide interim nitrogen and phosphorous removal to these impacted surface water bodies in the early phases (Phases 1 and 2) of Core Program construction and many years in advance of the construction of the later phases of Core Program construction for these areas of Orleans. The Town proposes to eventually convert and incorporate these cluster wastewater treatment systems to serve as pump stations for the Core Program municipal sewer system. The Town anticipates that the Phase 2 sewer construction work will be completed in 2020. Construction of the remaining Core Program phases (Phases 3-6) is anticipated to be completed in 2032.

Septage Handling Facility

The Orleans WWTF will include facilities for a new septage receiving and handling station to replace the existing Tri-Town Septage Treatment Facility and will be designed to receive, treat and dispose of truck-transported septage from non-sewered areas in Orleans together with septage from the other Tri-Town District communities of Brewster and Eastham.

Sludge Handling Facility

The Orleans WWTF will also include new facilities for preparing remaining sludge materials resulting from the wastewater treatment and septage handling processes for off-site trucking for suitable reuse and disposal.

Non Structural Program Elements

The Orleans CWMP also calls for the implementation of a number of cost-effective non-structural elements designed to provide measurable reductions in nitrogen loading to the embayments surrounding Orleans such as fertilizer management, stormwater management, enhanced embayment flushing and land use controls.

According to the information provided in the SEIR, fertilizer use and stormwater runoff can contribute up to 7% and 8% of watershed nitrogen load to coastal embayments in Orleans, respectively. The Town has committed to implement fertilizer use controls to reduce the use of fertilizer products on lawns, gardens and agricultural areas in Orleans. The Town has also committed to adopting stormwater management regulations to reduce nutrient loading from surface runoff to embayments surrounding Orleans, and to pilot the potential use of enhanced

embayment flushing to increase the assimilative capacity of coastal embayments to reduce nitrogen loading by increasing their flushing rates. MassDEP has indicated that some of these non-structural program elements may hold promise for reducing nutrient loading to coastal embayments but will require an extensive evaluation by MassDEP to determine if an acceptable nitrogen reduction credit can be applied in the Orleans CWMP.

Water Quality and Wastewater Treatment

Marine Embayments

The SEIR includes a detailed discussion of the findings of the MEP Technical Reports and/or TMDLs established for Pleasant Bay, Rock Harbor, Namskaket and Little Namskaket embayments used by the Town in the design of the Final Orleans CWMP. The Town has continued to participate in MEP's efforts to conduct water quality sampling and identify nutrient loading problems for the Town's coastal embayments. The Technical Reports produced by the MEP are used by MassDEP and the US Environmental Protection Agency (EPA) to establish Total Maximum Daily Loads (TMDLs) for nitrogen loading to these coastal emabyments and their tributaries. The MEP has provided Technical Reports for Pleasant Bay and the Northside Cape Cod Bay embayments of Rock Harbor, Namskaket and Little Namskaket Creek. The final MEP Technical Report for Nauset Marsh has been delayed. MassDEP and EPA have established TMDLs for Pleasant Bay and its coastal tributaries.

The TMDLs for the Northside Cape Cod Bay embayments has not yet been released. As described in the SEIR and the comments received from CCC, the Town incorporated information from the draft MEP Technical Report findings for Nauset Marsh in the Town's final design of the Orleans CWMP. Specifically, the Orleans CWMP includes a conservative target percentage (55%) nitrogen removal for Nauset Marsh. CCC supports the Town's interim use of this nitrogen removal estimate for Nauset Marsh. According to the comments received from MassDEP and CCC, the estimated nitrogen loading reductions resulting from the Town's phased construction of the Core Program are consistent with published or expected TMDLs for the watersheds and embayments surrounding the Town of Orleans. As a condition of its approval of the Orleans CWMP project, CCC will require the Town to review the final MEP Report for Nauset Marsh when it becomes available to determine what if any revisions to the Orleans CWMP may be needed to address nutrient loading and water quality issues affecting the Nauset Marsh/Town Cove embayment.

MassDEP and CCC have requested that the Town provide confirmatory modeling results using the Linked Water Quality Model to identify estimated reductions in nitrogen loading and interim water quality improvements associated with each phase of the Town's Core Program sewer construction program. The Town will be required to complete the confirmatory modeling

for the Orleans CWMP as a condition of MassDEP's Groundwater Discharge Permit and CCC's Development of Regional Impact (DRI) approval process. MassDEP's comments on the SEIR identified the need for additional water quality modeling at the Little Naskaket Marsh and renewed monitoring and characterization of the Tri-Town plume. According to MassDEP comments, the wastewater plume from the Tri-Town site was last monitored in 2001 by the USGS and determined to be moving in a northwesterly direction. MassDEP has indicated that the Town will be required to fully characterize the plume's direction and extend of its leading edge as part of the Town's ongoing water quality monitoring program responsibilities. Studies of the Tri-Town wastewater plume and their findings will be made part of the Adaptive Management Plan and included in the Town's annual TMDL Compliance Report described below.

Freshwater Ponds

As described in the SEIR, Phase 2 work will include the construction of five separate below-ground cluster wastewater treatment systems with approximately 11 miles of additional gravity sewers and pump stations to serve neighborhoods located in the headwaters of the watersheds for four impacted coastal embayments and one freshwater pond including Paw Wah Pond, Lonnies Pond, Arey's Pond, Mill Pond and Baker's Pond, respectively. Each of the five cluster wastewater treatment systems will have a design capacity to accommodate approximately 10,000 – 20,000 gpd of wastewater flow (15 – 30 properties) to achieve an effluent nitrogen concentration of 5- 8 mg/L. These cluster systems will provide interim nitrogen and phosphorous removal to these impacted surface water bodies in the early phases (Phases 1 and 2) of Core Program construction and many years in advance of the construction of the later Core Program sewer phases in these areas of Orleans. The Town proposes to eventually convert and incorporate these cluster wastewater treatment systems to serve as pump stations for the Core Program municipal sewer system. The Phase 2 sewer construction work is expected to be completed in 2018. Construction of the remaining Core Program phases (Phases 3-6) is anticipated to be completed by 2030.

In comments previously submitted on the EENF, CCC recommended that the Town consider constructing an interim cluster wastewater collection and treatment system to serve the neighborhoods located in the headwaters of for Cedar Pond area as part of the Town's Phase 1 Core Program work. According to the information provided in the SEIR, factors contributing to the impairment of Cedar Pond have not yet been adequately identified. The Town has committed to review the forthcoming amended MEP Report for Rock Harbor when it becomes available to re-evaluate the need for constructing a cluster sewer system to serve the Cedar Pond neighborhoods.

Orleans Wastewater Treatment Facility

The proposed Orleans WWTF will have an initial design capacity of 0.64 MGD and will employ a 4-stage Bardenpho nitrogen removal process that will achieve nitrogen effluent concentrations of 3-5 milligrams per liter (mg/l) of total effluent Nitrogen. Treated wastewater effluent will be discharged to 10 rapid infiltration beds. The Town completed a review of existing hydrogeological studies, hydraulic load testing and other groundwater modeling analyses and determined that the Tri-Town site has an effluent disposal capacity (approximately 1.78 mgd) to accommodate the Core Program's wastewater flows. As discussed below, the Orleans WWTF is designed with reserve treatment capacity to accommodate the treatment of potential future additional wastewater flows anticipated from sewering the entire Town of Orleans under the Town's Expanded Program design. Acoording to the information provided in the SEIR, under the Extended Program, a total of 1.14 MGD of wastewater flow will be collected from 5,300 individual properties for treatment at the Orleans WWTF. According to the Town, construction of the Extended Program would require an additional 15-20 years from the completion of the Core Program sewer construction work.

The treatment and on-site disposal of the Core Program's wastewater flows will utilize approximately 60% of the infiltration system's capacity. The disposal of treated effluent under the Regional Program would utilize approximately 90% of the infiltration system's discharge capacity. The disposal of treated effluent under the Town's Extended Program would exceed the infiltration system's capacity and require one or more additional off-site groundwater disposal sites or water reuse options.

As described in the SEIR, approximately 67% of the treated wastewater effluent from the Tri-Town site will discharge to Namskaket Marsh, 9% will discharge to Little Namskaket Marsh and approximately 25% will discharge to Cape Cod Bay. The MEP Reports for the Namskaket and Little Namskaket Marsh systems indicate that these embayments have adequate assimilative capacity to prevent nitrogen overloading from the discharge of the Core Program's treated wastewater flows. The Town has concluded that the disposal of treated effluent from the Orleans WWTF will not impact local groundwater and surface water resources including existing water table mound heights and nutrient loading to both the Namskaket Marsh and Little Namskaket Marsh. The Town has committed to monitor groundwater resources around the periphery and down gradient of the Orleans WWTF site to identify any impacts on groundwater resources and coastal embayments surrounding the Town of Orleans. According to the comments received from MassDEP, this groundwater monitoring commitment will be incorporated into MassDEP's Groundwater Discharge Permit for the Orleans WWTF. CCC has indicated that the Town will be required to conduct groundwater monitoring of the Tri-Town site as part of the Town's Adaptive Management Plan as a condition of CCC's DRI approval process.

Adaptive Management Plan (AMP)

The Orleans CWMP contains an AMP that identifies a systematic process for determining the effectiveness of the early phases of Core Program construction and the need for any revisions to the Orleans CWMP before initiating later Core Program construction phases. The AMP includes a Groundwater and Surface Water Quality Monitoring Plan that identifies specific annual water quality monitoring activities to be completed by the Town for the Tri-Town Site area, sensitive coastal embayments and select freshwater ponds in Orleans. The AMP requires the Town to coordinate its ongoing water quality monitoring activities with MassDEP, CCC, and the ongoing water quality monitoring and modeling activities in Orleans being carried out by MEP, the United States Geological Survey (USGS), the Pleasant Bay Alliance, the Orleans Ponds Coalition and the Orleans Marine and Fresh Water Quality Task Force.

The AMP also requires the Town to prepare an annual TMDL Compliance Report to document the reductions in watershed nitrogen loads achieved from the Town's phased sewer construction program. MassDEP will review the TMDL Compliance Report to determine the Town's compliance with the established TDMLs included in the Orleans CWMP. The TMDL Compliance Report will also be used to identify the need to make any adjustments or mid-course corrections to the Orleans CWMP prior to initiating the next phase of project construction. The annual TMDL Compliance Report will be distributed to MassDEP, CCC, MEP, local area watershed associations and representatives from neighboring towns.

Comments received from the Sierra Club, Clean Water Action and others have requested that the Orleans CWMP incorporate a monitoring program to identify the presence of contaminants of emerging concern (CECs) in wastewater flows and effluent discharges at the Orleans WWTF. According to MassDEP, no regulations or policies are in place to govern the monitoring or treatment of CECs at WWTFs as this issue is currently being studied by MassDEP, the US Environmental Protection Agency (EPA) and others. MassDEP has indicated that when such CEC policies and regulations are established, they could be included in the Town's AMP for the Orleans CWMP. I ask that the Town work closely with MassDEP to ensure that the final design of the Orleans WWTF may be modified in the future to accommodate potential future opportunities for CEC monitoring and treatment.

Wetlands and Waterways

Most of Orleans' proposed Core Program sewer construction project is located within existing roadway right-of-ways. According to the information provided in the SEIR, the Town's sewer project will not directly impact BVW resources. The Town has indicated that the Core Program sewer line routes and/or pumping station locations may encroach in the 100-foot buffers

of regulated wetland resource areas and result in impacts to wetland buffer zone area. Prior to construction of projects within the resource area buffer zones, the Town will apply for wetlands related permits, in accordance with MassDEP and the Orleans Conservation Commission regulations. I anticipate that the Town will continue to examine alternatives that avoid impacts to wetland resource areas, their associated buffer zones, riverfront protection areas, and 100-year flood plain areas during permit review.

According to the SEIR, the Core program construction activities will not be located within tidelands and will not require a Chapter 91 License from MassDEP. The project may be revised as it advances to final design and permitting. In the event the project undergoes further revisions that result in the alterations to tidelands, the Town will need to contact the MEPA Office to determine if further MEPA review is required to address impacts to waterways and tidelands and if a Public Benefits Determination will be required.

Rare Species

As described in the SEIR, the Tri-Town Septage Treatment Facility site, is located within Priority Habitat for the Eastern Box Turtle (*Terrapene carolina*), the Diamond-backed Terrapin (*Malaclemys terrapin*), Salt Reedgrass (*Spartina cynosuroides*) and Mitchell's Sedge (*Carex mitchelliana*). According to NHESP's previous comments on the EENF, the construction of the Orleans WWTF will occur within mapped habitat for the Eastern Box Turtle (Terrapene carolina). The Town, in consultation with NHESP, completed an evaluation of alternative site layouts for the Orleans WWTF facility. The SEIR includes a detailed description of the Town's revised site layout for the Orleans WWTF that locates the facility's rapid infiltration beds to the northern most portion of the site and maximize the reuse of existing disturbed areas and septage facility infrastructure for wastewater treatment. According to the Town, the revised site layout will result in the permanent alteration of approximately 4.9 acres of on-site habitat and will avoid fragmentation of undisturbed habitat areas within the proposed Orleans WWTF site to avoid a 'take' of the Eastern Box Turtle. NHESP's comments on the SEIR indicate that the construction of the Orleans WWTF will create temporary disturbances from site grading and may result in more than 5 acres of impact to mapped habitat for the Eastern Box Turtle. NHESP anticipates that the Town may be able to further reduce the projects temporary impacts to habitat by revising the project's proposed site grading and re-vegetation plans.

I ask that the Town continue to work closely with NHESP and consult with the Orleans Conservation Commission during the final CWMP project design and for each phase of Core Program construction to identify necessary construction and post-construction conditions and commitments to avoid adverse impacts to resource area habitats for state-listed species that may be located within and adjacent to the Orleans WWTF site, the five local cluster system project sites and the Core program sewer collection area.

Historical/Archeological Resources

As described in the SEIR, portions of the Core Program's sewer construction work are located within the Old King's Highway Regional Historical District (OKHRHD). The Town has committed to design and construct above ground sewer pump stations located within the OKHRHD with appropriate architectural features consistent with OKHRHD standards. According to the Town, the proposed cluster wastewater treatment systems may also be located within or adjacent to areas where archaeological resources may be present. The Town has committed to complete a reconnaissance archeological survey for each of these cluster site locations. MHC recommends that the Town submit to MHC for review and comment detailed project plans for Core Program construction phase as they may become available. Detailed project plans for Core Program construction phase should also be submitted to the OKHRHD for review and comment I ask that the Town continue to work closely with MHC during final project design and prior to each successive sewer construction phase to identify opportunities to avoid, minimize and mitigate project construction impacts to historic and archeological resources in the project area.

Greenhouse Gas Emissions (GHG)

The project requires an EIR and therefore is subject to the requirements of the MEPA Greenhouse Gas Emissions Policy and Protocol ("the Policy"): http://www.mass.gov/envir/mepa/downloads/GHGPolicyRev1108.pdf . The policy requires project proponents to quantify the direct and indirect CO_2 emissions from the proposed project, including CO_2 emissions associated with the buildings & plant operations, and to compare those emissions to a project baseline, which includes no-build conditions as well as an assessment of the emissions associated with the current effective building code ("base case").

In this instance, the Town consulted with MassDEP, DOER and EPA and developed a "base case WWTF" using GHG emissions data obtained from EPA's Energy Star Portfolio Manager database for comparable WWTFs having similarly sized treatment capacities, wastewater nutrient loads and seasonal demand fluctuations. The Town's estimated GHG emissions for the Base Case WWTF is approximately 900 tons of carbon dioxide per year (CO_2/yr). The SEIR presented an evaluation of 20 GHG reduction mitigation measures associated with wastewater treatment processing, building systems and facility operation and management. The Town has committed to incorporate a number of GHG reduction measures related to Building and Process systems for the Orleans WWTF that will result in a reduction of approximately 64 tons CO_2/yr from the Base Case WWTF, a reduction of approximately 6 percent. Comments received from the Department of Energy Resources (DOER) indicate that even greater reductions may be achieved by through the use of alternative nitrogen demand technology. I encourage the Town to

consider DOER's comments. The Town also identified 11 additional GHG reduction measures including the use of on-site renewable energy (solar photovoltaic (PV), Wind Turbine) that the Town has committed to further explore during final design of the Orleans WWTF. As described in the SEIR, these 11 additional GHG reduction measures could result in a reduction of approximately 309 tons CO_2/yr (34.3%) from the Base Case WWTF. The Town should commit to continue to work closely with MassDEP and DOER during final WWTF design and permitting to identify and incorporate appropriate energy efficiency measures into the buildings, treatment processes and operations for the Orleans WWTF. MassDEP has indicated that it will work with the Town to incorporate these GHG reduction measures through its project financing and permitting authority. Upon completion of the construction of the Orleans WWTF, the Town should provide a certification to the MEPA Office signed by an appropriate professional (e.g., engineer, architect, general contractor) indicating that the all of the GHG mitigation measures committed to by the Town as described in the SEIR and this section of the Certificate that collectively will reduce Building and Process systems GHG Emissions for the proposed project by at least 6 percent have been incorporated into the Orleans WWTF project. This certification should be supported by as-built plans. For those measures that are operational in nature (i.e. TDM, recycling) the Town should provide an updated plan identifying the measures, the schedule for implementation and how progress towards achieving the measures will be obtained. MassDEP should incorporate this self-certification requirement into its Section 61 finding for this project.

Sewering and Growth Management

The SEIR includes a discussion of potential land use control mechanisms to limit unwanted secondary growth related to the construction of the Town's Core Program sewer project. The Orleans Board of Health adopted its Nutrient Management Regulation in 2008 restricting wastewater flow to 110 gpd per 10,000 sf of lot area for new development or expansion of existing development. The Town is proposing to implement a 'flow-neutral' Sewer Use Regulation to be administered through the Orleans Board of Health, which would limit the redevelopment of existing properties by restricting the amount of additional wastewater flow/nitrogen load from the redeveloped property to the amount of wastewater flow from the property to what is allowed under Title 5 and local zoning. The Town is also proposing to adopt Section 1A of the Chapter 83 of the Massachusetts General Laws to enable the Town to implement a "checkerboard" sewer connection bylaw that will allow the Town to select specific lots that will be connected to the municipal sewer system and lots that do not need sewering and therefore will not be allowed to connect to the new sewer system. Lastly, the Town is also considering implementing an accelerated program of open space acquisition in nitrogen-sensitive watersheds to avoid the potential nitrogen loads from the future development of these currently undeveloped properties. The Town should adopt and implement any proposed growth by-laws, regulations, and policies prior to the construction of any new sewers.

Costs to Homeowners

As described in the SEIR/Final CWMP, the Core Program will be constructed in six phases over 15-20 years and will have an estimated capitol cost of approximately $150,000,000. The estimated operation and maintenance (O&M) costs for the Core Program total approximately $1.4 million dollars. According to the Town, construction of the Expanded Program to extend the new centralized sewer system to the remaining properties located outside of the Core program area will cost an additional $96,000,000 in capital costs. The Town proposes to recover 80% of the project's municipal debt service through user and non-user property taxation and 20% through betterment assessments to be paid by users of the sewer system. The SEIR provides average cost estimates (capital and O&M) for households connected to the Core Program sewer system ($2,592.00) and those households not connected to the Core Program sewer system ($2,544.00). According to the information provided in the SEIR, the proposed Core Program of new sewer construction may qualify for available state and/or federal loan and grant assistance including the State Revolving Fund (SRF) and the US Department of Agriculture's Rural Development Grant program thereby reducing the average cost estimates (capital and O&M) for households connected to the Core Program sewer system from $2,592.00 to $1,692.00 and those households not connected to the Core Program sewer system from $2,544.00 to $1,965.00.

Future Sewer Expansion

The Town's Core Program sewer collection system has been designed to accommodate larger wastewater flows associated with the potential future expansion of new sewers to the entire Town of Orleans (Expanded Program) and/or additional wastewater flows from the neighboring towns of Eastham and Brewster (Regional Program).

Expanded Program

Under the Expanded Program, new sewers would be extended to all of the Town of Orleans and would result in the collection and conveyance of a total of 1.14 MGD of wastewater from 5,300 individual properties for treatment at the Orleans WWTF. As mentioned elsewhere in this Certificate, additional wastewater disposal sites and/or treated effluent reuse options may be required to accommodate the disposal of the Expanded Program wastewater flows.

Regional Program

The SEIR includes a detailed discussion of potential regional approaches to address the wastewater treatment and disposal needs for the Towns of Orleans, Eastham and Brewster, and the regional issues pertaining to nutrient loading, wastewater treatment and disposal affecting the Nauset Marsh/Town Cove and Pleasant Bay coastal embayments.

According to the comments received from the Town of Eastham, Eastham recently completed its wastewater planning study and identified as its preferred alternative a regional wastewater treatment option with the Town of Orleans involving the conveyance of a portion of Eastham's wastewater flows from the Nauset/Town Cove/Rock Harbor Watersheds to the Orleans WWTF for treatment and disposal. The Town of Eastham has expressed an interest in working with the Town of Orleans to identify opportunities for constructing its sewer connection to the Orleans WWTF in the early phases of Orleans' Core Program construction.

The SEIR indentifies a number of options for a regional wastewater treatment approach with the Town of Brewster including the conveyance of a portion of Brewster's wastewater flows from the Pleasant Bay Watershed to the Orleans WWTF for treatment and disposal and/or locating a new satellite WWTF in the Town of Brewster to treat a portion of Orleans' and Brewster' wastewater flows from the Pleasant Bay Watershed. As described in the comments received from the Town of Brewster on the SEIR, Brewster has recently initiated efforts to complete an Integrated Water Resources Management Plan. As part of its planning process, the Town of Brewster has expressed a desire to continue to work with the Town of Orleans, MassDEP and others to address regional water and wastewater management issues affecting their shared watersheds and coastal embayments.

I ask the Towns of Orleans, Eastham and Brewster work closely together with MassDEP and CCC and others including the Pleasant Bay Resource Management Alliance and the Cape Cod Water Protection Collaborative to continue the discussion of possible opportunities to integrate the Town of Orleans' wastewater treatment planning efforts with the water and wastewater management planning efforts being undertaken by the Towns of Eastham and Brewster.

Construction Impacts

The construction period will be the major source of impacts from the project, including impacts from earth moving, impacts to vegetation, potential impacts from erosion and sedimentation, traffic impacts on adjacent roadways, and impacts to adjacent land uses. Construction period impacts and mitigation measures have been described in the SEIR, including impacts from noise and dust, impacts on trees and other vegetation, and traffic impacts. This section of the SEIR includes a discussion of measures that will be taken by the Town to minimize and mitigate construction period impacts (in particular impacts on sensitive receptors or exceptional resources). Given the availability of Ultra Low Sulfur Diesel (ULSD) fuel and the requirements for off-road engines in 2010, the construction equipment for the project should operate on ULSD fuel to reduce emissions of fine particulate matter. The Town should consult with MassDEP to discuss additional construction period diesel mitigation measures. I strongly encourage the Town to commit to using lower emission equipment in addition to requiring its contractors to retrofit diesel-powered equipment with emissions controls, such as particulate filters or traps, and use low-sulfur diesel fuel. The Town should require its contractors to use

On-Road Low Sulfur Diesel (LSD) fuel in their off-road construction equipment which can increase the removal of particulate matter (PM) by approximately 25% beyond that which can be removed by retrofitting diesel-powered equipment. All construction-related refueling and equipment maintenance activities should be conducted under cover on impervious surface areas with containment, and outside of any wetlands resource areas, endangered species habitat areas, residential areas and wellhead protection areas.

The Town should develop and enforce a spills contingency plan to address potential releases of oil and/or hazardous materials from pre and post construction activities as recommended by MassDEP. To the extent feasible, existing access routes within the ROW will be used for construction access. In areas where access roads do not exist, the Proponent will construct temporary access roads along existing land contours to minimize grading requirements for construction vehicle access. Best Management Practices (BMPs) that will be implemented during construction include the use of swamp mats and erosion control barriers, and a Stormwater Pollution Prevention Plan.

Mitigation and Section 61 Findings

The SEIR includes a separate chapter on mitigation measures and proposed Section 61 Findings for all state permits and approvals required for the project. This section of the SEIR provides a description of the Town's proposed mitigation plan, and discusses the value of the proposed mitigation in terms of the resources it provides and the opportunities for open space protection, and active and/or passive recreation it affords. Final Section 61 Findings will be prepared by state agencies issuing permits for this project and will include conditions considered binding upon the Proponent as mitigation commitments. State agencies and the Town should forward final copies of Section 61 Findings to the MEPA Office for the project file and for notice in the Environmental Monitor. I ask the Town to continue to work closely with MassDEP, CCC and the Pleasant Bay Resource Management Alliance to design and implement a sustainable Comprehensive Wastewater Facilities Plan and mitigation plan for the Town of Orleans that will help to offset the proposed project's municipal sewering impacts.

Conclusion

After a thorough consideration of the comments received from MassDEP and others, I am satisfied that any outstanding design issues relating to sewer layout and construction phasing will be fully considered and addressed during state and local permitting. As noted elsewhere in this Certificate, the Town should continue to work closely with MassDEP, NHESP and MHC during final project design.

January 28, 2011
DATE

Richard K. Sullivan, Jr., Secretary

Comments received:

01/19/11 Division of Marine Resources (DMF)
01/19/11 Pleasant bay Resource Management Alliance
01/19/11 Town of Brewster
01/19/11 Mary Hartley
01/20/11 Cape Cod Commission (CCC)
01/20/11 David Farquhar
01/20/11 Department of Energy Resources (DOER)
01/20/11 Kevin H. Cassidy
01/20/11 Beverly M. Carney
01/21/11 MA Department of Environmental Protection (MassDEP) – SERO
01/21/11 Sierra Club, Cape Cod and the Islands
01/21/11 Alan McClennen, Jr. FAICP
01/21/11 Beverly M. Carney
01/21/11 Ben A. Buck
01/21/11 Clean Water Action
01/21/11 Brian and Judy Embleton
01/21/11 Victoria L. Reis
12/22/11 Massachusetts Historical Commission (MHC)
01/25/11 Town of Eastham
01/27/11 Natural Heritage & Endangered Species Program (NHESP)

SEIR #14414
RKS, Jr./NZ/nz

ATTACHMENT 4b

2009 Environmental Notification Form

Commonwealth of Massachusetts
Executive Office of Environmental Affairs ■ MEPA Office

ENF Environmental Notification Form

For Office Use Only *Executive Office of Environmental Affairs*
EOEA No.: 14414
MEPA Analyst: Nick Zavolas
Phone: 617-626-1030

The information requested on this form must be completed to begin MEPA Review in accordance with the provisions of the Massachusetts Environmental Policy Act, 301 CMR 11.00.

Project Name: Town of Orleans Comprehensive Wastewater Management Plan		
Street: 29 Overland Way (Proposed Wastewater Treatment Facility Site)		
Municipality: Orleans	Watershed: Cape and Islands	
Universal Tranverse Mercator Coordinates:	Latitude: 41° 46' 56" Longitude: 70° 0' 20"	
Estimated commencement date: July 2012	Estimated completion date: 2030	
Approximate cost: $150 million (2008 dollars)	Status of project design: Conceptual %complete	
Proponent: Town of Orleans		
Street: 19 School Street		
Municipality: Orleans	State: MA	Zip Code: 02653
Name of Contact Person From Whom Copies of this ENF May Be Obtained: Heather Merriman		
Firm/Agency: Wright-Pierce	Street: 200 Brickstone Square Suite 505	
Municipality: Andover	State: MA	Zip Code: 01810
Phone: 978-470-0666	Fax: 978-470-3558	E-mail: hbm@wright-pierce.com

Does this project meet or exceed a mandatory EIR threshold (see 301 CMR 11.03)?
☒Yes ☐No

Has this project been filed with MEPA before?
☐Yes (EOEA No._____) ☒No

Has any project on this site been filed with MEPA before?
☐Yes (EOEA No._____) ☒No

Is this an Expanded ENF (see 301 CMR 11.05(7)) requesting:

a Single EIR? (see 301 CMR 11.06(8))	☒Yes	☐No
a Special Review Procedure? (see 301CMR 11.09)	☒Yes*	☐No
a Waiver of mandatory EIR? (see 301 CMR 11.11)	☐Yes	☒No
a Phase I Waiver? (see 301 CMR 11.11)	☐Yes	☒No

Identify any financial assistance or land transfer from an agency of the Commonwealth, including the agency name and the amount of funding or land area (in acres):

SRF loans expected from the Massachusetts Environmental Trust (amount TBD)

Are you requesting coordinated review with any other federal, state, regional, or local agency?
☒Yes (Cape Cod Commission, Development of Regional Impact) ☐No

* (Basis for requested Special Review Procedure)

List Local or Federal Permits and Approvals:

- Compliance with the federal Clean Water Act through nitrogen-based TMDLs as implement by DEP.
- The project must comply with the Cape Cod Commission's Regional Policy Plan and undergo review as a Development of Regional Impact (DRI).
- Compliance with the regulations of the Old Kings Highway Regional Historic District is required for above-grade structures located in the District (all areas of Orleans north and west of Route 6A).
- The Town must issue building permits for treatment facilities and pumping stations after compliance with the State Building Code is demonstrated.

(See Section 11 of Draft CWMP Report, April 2009)

State Permits and Approvals:

- DEP approval of the CWMP.
- DEP Groundwater Discharge Permitting under 310 CMR 5.0. A groundwater discharge permit is required for the new wastewater facilities planned for the Tri-Town site. Depending on the plan for short-term septage management, the existing permit held by the Tri-Town District may need to be extended for two or more years beyond its current 2012 end date.
- DEP Plan Review is required for the proposed new wastewater treatment facility, once final plans and specifications have been prepared.
- DEP Site Assignment under MGL Chapter 83 Section 6 is required for any publicly-owned wastewater site. The existing site assignment for the Tri-Town site may need to be expanded to account for the proposed wastewater facilities.
- DEP Sewer Extension Permits will be needed for system expansion after completion of the first phase.
- Compliance with the Massachusetts Wetlands Protection Act and local supplemental bylaws is necessary for all impacts on protected resources.
- Review must be conducted under the Massachusetts Natural Heritage and Endangered Species Program, pursuant to the Massachusetts Endangered Species Act.
- Review must be conducted under the program of the Massachusetts Historical Commission.
- All activities must be consistent with the two Areas of Critical Environmental Concern.
- Permits are required from Mass Highway for all construction work in state roads.

(See Section 11 of Draft CWMP Report, April 2009)

Which ENF or EIR review threshold(s) does the project meet or exceed (see 301 CMR 11.03):

- ☐ Land
- ☐ Water
- ☐ Energy
- ☐ ACEC
- ☒ Rare Species
- ☒ Wastewater
- ☐ Air
- ☐ Regulations
- ☐ Wetlands, Waterways, & Tidelands
- ☐ Transportation
- ☐ Solid & Hazardous Waste
- ☒ Historical & Archaeological Resources

Summary of Project Size & Environmental Impacts	Existing	Change	Total
LAND			
Total site acreage	27		
New acres of land altered		6.5	
Acres of impervious area	4	2	6
Square feet of new bordering vegetated wetlands alteration		0	
Square feet of new other wetland alteration		0	
Acres of new non-water dependent use of tidelands or waterways		0	
STRUCTURES			
Gross square footage	43,200	16,000	59,200
Number of housing units	0	0	0
Maximum height (in feet)	25	25	25
TRANSPORTATION			
Vehicle trips per day	30	-4	26
Parking spaces	7	5	12
WATER/WASTEWATER			
Gallons/day (GPD) of water use	0	640,000	640,000
GPD water withdrawal	0	0	0
GPD wastewater generation/ treatment	0	504,000	504,000
Length of water/sewer mains (in miles)	0	74	74

State Permits & Approvals

- ☒ Order of Conditions
- ☐ Superseding Order of Conditions
- ☐ Chapter 91 License
- ☐ 401 Water Quality Certification
- ☐ MHD or MDC Access Permit
- ☐ Water Management Act Permit
- ☐ New Source Approval
- ☒ DEP or MWRA Sewer Connection/ Extension Permit
- ☒ Other Permits (*including Legislative Approvals*) – Specify:

See list on Page 2.

CONSERVATION LAND: Will the project involve the conversion of public parkland or other Article 97 public natural resources to any purpose not in accordance with Article 97?

☐Yes (Specify_____) ☒No

Will it involve the release of any conservation restriction, preservation restriction, agricultural preservation restriction, or watershed preservation restriction?

☐Yes (Specify_____) ☒No

PROJECT DESCRIPTION: The project description should include **(a)** a description of the project site, **(b)** a description of both on-site and off-site alternatives and the impacts associated with each alternative, and **(c)** potential on-site and off-site mitigation measures for each alternative.

A) Project Description

The Town of Orleans has completed a draft Comprehensive Wastewater Management Plan that identifies and evaluates 3 alternative plans to guide the improvement of coastal estuaries and freshwater ponds to meet state and federal mandates. The Recommended Plan is highly adaptable to accommodate measured progress in water quality improvement, future regional opportunities, effectiveness of lower-cost alternatives, and availability of favorable financing. To meet current mandates, a municipal sewer system is needed to serve one-half of Orleans' developed properties at an estimated capital cost of $150 million to be spent over 15 to 20 years. That system includes 74 miles of municipal sewers, a single wastewater treatment facility and associated sludge/septage handling facilities.

B) Description of Impacts

The Recommended Plan is one of three alternative plans investigated by the town. These three plans are described in Section 6 of the draft CWMP. Sections 7 and 8 compare and contrast the three plans. Refer to Report Section 8.5 for a detailed list of potential environmental impacts including:

- *Surface water quality*
- *Groundwater quality*
- *Wetlands*
- *Floodplains*
- *Coastal resources*
- *Open space and recreation*
- *Rare and endangered species*
- *Archaeological and historic resources*
- *Traffic*
- *Air Quality*
- *Noise*
- *Energy*
- *Generation of solid waste*
- *Public health*
- *Community growth and land use*

C) Potential Mitigation Measures

There are many mitigation measures that will be employed in the implementation of the Recommended Plan that will lessen its environmental impacts. These include:

- *Restricting sewer construction work to the period of October to May to avoid periods of high traffic;*
- *Segmenting sewer work on public streets to avoid protracted closures;*
- *Designing sewer lines and pump stations to avoid floodplains and to minimize encroachment on the buffers of wetlands and other protected resource areas;*
- *Restricting work hours on construction sites near residential areas;*
- *Requiring contractors to implement dust control measures;*
- *Erosion and siltation controls at all construction sites as part of site-specific stormwater management plans;*
- *Compliance with all terms of Orders of Conditions for work in wetland buffers;*
- *Installation of odor and noise control systems on operating equipment and facilities;*
- *Implementation of policies that restrict potential odor-generating activities to times of the day with the least impact;*
- *Compliance with applicable standards for construction activities near historic structures;*
- *Facility siting to include appropriate mitigating measures as necessary for habitat of rare and endangered species;*
- *Facility site design to include vegetated berms and appropriate plantings to maximize natural buffers; and*
- *Selection of wastewater treatment equipment to minimize energy use and maximize nitrogen removal.*

Refer to Report Section 11 of the draft CWMP for more detail.

ATTACHMENT 4c

2009 Certificate of the Secretary of Energy and Environmental Affairs on the Expanded Environmental Notification Form

The Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Deval L. Patrick
GOVERNOR

Timothy P. Murray
LIEUTENANT GOVERNOR

Ian A. Bowles
SECRETARY

Tel: (617) 626-1000
Fax: (617) 626-1181
http://www.mass.gov/envir

July 10, 2009

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
EXPANDED ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Town of Orleans Comprehensive Wastewater Management Plan
PROJECT MUNICIPALITY	: Town of Orleans
PROJECT WATERSHED	: Cape and Islands
EOEA NUMBER	: 14414
PROJECT PROPONENT	: Town of Orleans
DATE NOTICED IN MONITOR	: May 6, 2009

Pursuant to the Massachusetts Environmental Policy Act (G. L. c. 30, ss. 61-62I) and Section 11.03 of the MEPA regulations (301 CMR 11.00), I hereby determine that this project **requires** the preparation of an Environmental Impact Report (EIR).

In accordance with Section 11.05(7) of the MEPA regulations, the Town of Orleans (the Town) has submitted an Expanded Environmental Notification Form (EENF) with a request that I allow the Proponent to fulfill its EIR obligations under MEPA with a Single EIR (SEIR), rather than the usual process of a Draft and Final EIR. The EENF received an extended comment period pursuant to Section 11.06(8) of the MEPA regulations and the Town voluntarily extended the comment period an additional four weeks. The EENF includes clear descriptions of the project, a description of the extensive planning and alternatives analysis conducted to date, identifies potential environmental impacts associated with the project and provides commitments to mitigate impacts. Comments received from the Department of Environmental Protection (MassDEP), the Cape Cod Commission (CCC) and others indicate overwhelming support for the analysis and conclusions included in the EENF and that it is consistent with legal requirements. Based on a review of the EENF and after consultation with state agencies, I hereby find that the EENF meets the regulatory requirements and I am permitting the Proponent to file a SEIR in fulfillment of Section 11.03 of the MEPA regulations.

The Scope described below is intended to identify additional analysis and information necessary to complete MEPA review and ensure that impacts and issues are fully analyzed.

Project Overview

The Town of Orleans' comprehensive wastewater management process has been undertaken for the purposes of:

1) Evaluating and planning for the impacts to the Town's marine and freshwater water resources from anticipated future residential and commercial growth and development in the Town of Orleans over the 20-year project planning period (ending in 2030);

2) Evaluating and quantifying the Town of Orleans' existing and future contributions to nitrogen loading of coastal embayments and phosphorous loading of freshwater ponds from the Town's on-site septic systems over the 20-year project planning period;

3) Evaluating the feasibility of centralized and de-centralized municipal sewer options to meet the estimated 2030 nitrogen control needs and Total Maximum Daily Loads (TMDLs) established for the marine embayments surrounding Orleans;

4) Evaluating alternative methods for the disposal of treated wastewater including on-site and off-site groundwater disposal using rapid infiltration basins and wastewater reuse for landscape spray irrigation, with the intent of reducing groundwater discharges from the proposed Orleans Wastewater Treatment Facility (WWTF);

5) Evaluating the feasibility of non-structural and non-traditional nutrient management techniques to further reduce nutrient loading to the marine embayments surrounding Orleans; and,

6) Reviewing the long-term effectiveness of regional wastewater treatment and disposal options involving the Towns of Orleans, Eastham and Brewster.

The Town's draft comprehensive wastewater management plan (Draft CWMP) has been designed to achieve reductions of nitrogen loading and meet nutrient Total Maximum Daily Loads (TMDLs) to the Town of Orleans' coastal embayments including Pleasant Bay, Nauset Marsh/Town Cove, Cape Cod Bay, and to achieve reductions of phosphorous loading to protect the water quality associated with a number of fresh water ponds located in Orleans over the 20-year project implementation period.

I note that the Inner Cape Cod Bay and Pleasant Bay have been designated as Areas of Critical Environmental Concern (ACECs) and Outstanding Resource Waters (ORW) under the Massachusetts Surface Water Quality Standards (314 CMR 4.00). Extensive areas of Priority and Estimated Habitat of rare wildlife have been mapped by the Natural Heritage and Endangered Species Program ("NHESP") within each of these ACECs.

The Town's core sewer construction plan (Core Program) involves the six phase construction of new sewers including a new wastewater treatment facility (Orleans WWTF) to be located at the existing Tri-Town Septage Treatment facility located near the intersection of Route 6 and Route 6A at 29 Overland Way in Orleans. The Core Program includes the construction of approximately 74 miles of new municipal sewer pipe, and approximately 63 sewer pump stations. Under the Core Program, 0.64 million gallons per day (MGD) of wastewater flow will be collected from 2,800 individual properties (approximately 53% percent of the Town) in the 2030 design year for treatment and on-site disposal. As currently designed, the Draft CWMP incorporates reserved treatment capacity to accommodate the projected future 2030 build-out of Orleans including reserving approximately 17,000 gallons per day (gpd) of capacity at the Orleans WWTF for anticipated future development in the Town's downtown Central District. Construction of Phase 1 of the Core Program is expected to be completed in 2015 and will include the construction of the new Orleans WWTF (to operate at 50% design capacity) and approximately 15 miles of new sewers and 7 pump stations located primarily throughout the downtown area of Orleans. Phase 2 will include the construction of approximately 11 miles of additional gravity sewers and five separate cluster wastewater treatment systems each with a design capacity of 10,000 gpd to be located at the headwaters of the Paw Wah, Lonnie's, Arey's, Baker's and Mill Ponds. As described in the EENF, these cluster systems will provide interim nitrogen and phosphorous removal in advance of the construction of the later Core Program sewer phases. The Town proposes to eventually convert and incorporate these cluster wastewater treatment systems to serve as pump stations for the Core Program municipal sewer system. The Phase 2 sewer construction work is expected to be completed in 2018. Construction of the remaining Core Program phases (Phases 3-6) is anticipated to be completed by 2030.

The Orleans WWTF will include a new septage receiving station to replace the existing Tri-Town Septage Treatment Facility and will be designed to receive, treat and dispose septage truck-transported from non-sewered areas in Orleans together with septage from the other Tri-Town District communities of Brewster and Eastham. The remaining sludge materials resulting from the Orleans WWTF's treatment of wastewater and septage will be dewatered and trucked off-site for suitable reuse and disposal. The Draft CWMP also incorporates a number of non-structural elements designed to reduce nutrient loading including proposed programs for controlling the use of fertilizer products on lawns, gardens and agricultural areas, stormwater management and water conservation.

The Town's Draft CWMP has been designed to also accommodate potential additional future wastewater flows from the remaining unsewered areas of Orleans (Extended Program) and/or the neighboring towns of Eastham and Brewster (Regional Program). However, as described in the EENF, additional wastewater disposal sites or reuse options may be required to support these potential future sewer expansion programs. The Orleans Draft CWMP also incorporates an Adaptive Management Plan (AMP) that outlines a process for reporting the results of the Town's ongoing annual groundwater quality and marine habitat monitoring program to identify the need for any adjustments or mid-course corrections to the phased construction of the Core Program to achieve compliance with TMDLs for the coastal embayments surrounding Orleans.

State Permits and Jurisdiction

The project is undergoing review pursuant to Sections 11.03(5)(a)(3) and (5)(b)(1) of the MEPA regulations, because the project will likely involve the construction of sewer mains ten or more miles in length and the development of a new wastewater treatment facility with a capacity of more than 1,000,000 gallons per day. The project will require a Groundwater Discharge Permit, a Chapter 91 License, and a 401 Water Quality Certificate from MassDEP. The project must be reviewed by the Natural Heritage Endangered Species Program (NHESP) and the Massachusetts Historical Commission (MHC) because portions of the project occur within Priority Habitat and within or adjacent to recorded archaeological sites and archaeologically sensitive areas, respectively. It may require Federal Consistency Review with the Massachusetts Coastal Zone Management (MCZM) Office. It may also require a Construction Access Permit from the Massachusetts Highway Department. The project may need to obtain a Section 404 Permit from the U.S. Army Corps of Engineers. The project should comply with the National Pollutant Discharge Elimination System (NPDES) General Permit for stormwater discharges from a construction site. It will also require an Order of Conditions from the Orleans Conservation Commission and on appeal only, a Superseding Order of Conditions from MassDEP.

The Town anticipates applying for State Revolving Fund (SRF) loans for subsequent planning and construction of proposed sewer project. Therefore, MEPA jurisdiction is broad and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

SCOPE

The Town should prepare the SEIR/Final CWMP in accordance with Section 11.07 of the MEPA regulations as modified by this Certificate. The SEIR should include a copy of this Certificate. The SEIR should also contain copies of the comments received. The Town should circulate the SEIR to those who commented on the EENF, and to any party required by regulation.

Project Description

The SEIR should include a detailed executive summary explaining what is being proposed under the Town's Core Program and potential future Expanded Program and Regional Program and why. It should identify significant environmental benefits and impacts, and measures that will be taken to avoid, minimize and mitigate adverse impacts. The SEIR should describe the proposed schedule for the remaining phases of project planning, design, environmental permitting and review, and construction. Detailed information should be provided for each area where construction of new sewers or cluster systems are proposed, including maps that show where sewer lines, cross-country easements, pumping stations, and other facilities will be located. The SEIR should provide the best information currently available for the six sewer construction phases proposed under the Core Program, and explain what additional information is proposed for later collection and analysis. The SEIR should discuss the state permitting process for this project and describe how it will meet applicable performance standards.

Needs Analysis

A Needs Analysis was conducted to determine the nutrient loads generated by existing and future development and their respective septic systems in the Town of Orleans and the types of wastewater treatment and disposal alternatives that would be required to meet published and expected TMDLs for the coastal embayments and freshwater ponds in Orleans. In developing the Draft CWMP, the Town reviewed the total number of parcels located within each of the three watersheds for the marine embayments surrounding Orleans and freshwater pond watersheds, and estimated the water use, wastewater flows and nutrient loading to be generated in the 2030 project design year. Existing and future development parcels were evaluated to determine the need for sewer to address the water quality requirements and TMDLs of the Town's marine and freshwater water resources. Both MassDEP and I generally concur with the findings of the Needs Analysis.

Alternatives Analysis

The EENF includes an evaluation of decentralized, community, and regional wastewater treatment and disposal alternatives to address the Town's identified wastewater treatment needs. The Town's Draft CWMP describes a Core Program of sewering that involves the phased construction of a centralized wastewater collection, treatment and disposal system to serve approximately 53% of the Town's existing developed properties.

The SEIR should include a detailed description of the Town's preferred site layout for the proposed Orleans WWTF that would maximize the reuse of the existing septage facility infrastructure and avoid fragmentation of undisturbed areas within the site and a 'take' of the Eastern Box Turtle. The SEIR should consider incorporating the sewering of the Cedar Pond watershed area as part of the Town's Phase 1 Core Program construction activities.
The SEIR should include a discussion of additional wastewater disposal or reuse alternatives that may be required to support the Extended or Regional Programs.

Wastewater Treatment and Water Quality

Orleans Wastewater Treatment Facility

As described in the EENF, the Town conducted a review of hydrogeological studies, hydraulic load testing and other groundwater modeling analyses pertaining to the 26-acre existing Tri-Town District Septage Treatment Facility site (Tri-Town site). The Tri-Town site is located within the Namskaket Marsh embayment that has been found to have excess capacity to accept additional nitrogen loading. According to the information provided in the EENF, the majority of the treated wastewater recharged at the Tri-Town site will mix with groundwater and recharge Namskaket Marsh. The Town has concluded that the on-site disposal and groundwater recharge of treated effluent from the Orleans WWTF will not impact local groundwater and surface water resources including existing water table mound height and nutrient loading to the Namskaket Marsh embayment. As currently designed, the Orleans WWTF will employ a 4-stage Bardenpho nitrogen removal process that will provide treatment levels capable of achieving nitrogen effluent concentrations of 3-5 parts per million (ppm) with a designed capacity to treat and dispose up to 0.64 MGD. The Draft CWMP includes a commitment to monitor groundwater resources around the periphery and down gradient of the Orleans WWTF site to identify the impacts on groundwater resources and embayments surrounding the Town of Orleans. This monitoring program is expected to be incorporated into a MassDEP groundwater discharge permit for the Orleans WWTF.

The SEIR should provide a detailed description of the Town's proposed groundwater quality monitoring plan for the Tri-Town site. The SEIR should evaluate the Tri-Town site's capacity to treat the additional estimated wastewater flows to be generated under the potential future Expanded and the Regional wastewater treatment alternatives.

Marine Embayments

The Town has continued to participate in the Massachusetts Estuaries Project (MEP) to conduct water quality sampling and identify nutrient loading problems for the Town's coastal embayments. MEP was created by MassDEP, and the University of Massachusetts School of marine Science and Technology (UMass SMAST) to define the nitrogen limits of coastal estuaries in southeastern Massachusetts. The Technical Reports produced by the MEP are used by MassDEP and the US Environmental Protection Agency (EPA) to establish Total Maximum Daily Loads (TMDLs) for nitrogen loading to these coastal emabyments and their tributaries. According to the comments received from MassDEP, CCC and others, the estimated nitrogen loading reductions resulting from the Town's proposed phased Core Program for municipal sewer construction are consistent with published or expected TMDLs for the watersheds and embayments surrounding the Town of Orleans.

The SEIR should incorporate the findings of the MEP Technical Reports and/or TMDLs established for the Northside Cape Cod Bay and the Nauset Marsh/Town Cove embayments. The Town should use the Linked Water Quality Model to confirm the Core Program's ability to provide the necessary reductions in nitrogen loading to embayments surrounding the Town of Orleans in compliance with published or expected TMDLs. The SEIR should evaluate the benefit of expanding the Phase 1 sewer construction area to include properties located in the Cedar Pond watershed.

Freshwater Ponds

The Draft CWMP/EENF includes an evaluation of the impacts of phosphorous groundwater loading from residential land use on the water quality of large freshwater ponds and lakes located in Orleans. Using water quality monitoring results collected as part of the Cape Cod Ponds and Lakes Stewardship (PALS), the Town has identified the need to sewer properties located around Bolands, Baker, Ice House, Shoal and Cedar Ponds, and Crystal and Pilgram Lake. As described elsewhere in this Certificate, Phase 2 of the Town's Core sewering program includes the construction of five separate cluster wastewater treatment systems that will each serve 40-50 existing developed properties located in areas upgradient of a number of impaired freshwater ponds in Orleans including the Paw Wah, Lonnie's, Arey's, Baker's and Mill Ponds.

According to the Town, the construction and operation of these cluster systems in advance of later phases of the proposed municipal sewer system will significantly reduce phosphorous to groundwater and phosphorous loading to these ponds.

The SEIR should provide a detailed discussion of the proposed cluster wastewater treatment systems including proposed sites for locating cluster wastewater treatment systems locations, areas to be served, system design capacity and treatment efficiency. This section of the SEIR should include an analysis of the benefits of cluster systems to provide nitrogen removal from the Pleasant Bay tributaries. The Town should consider cluster treatment systems with treatment efficiencies and nitrogen removal rates of 5 parts per million (ppm). The Town should also re-evaluate the merit of the proposed cluster wastewater treatment systems for Bakers Pond and Cedar Pond and consider incorporating the sewering of the Cedar Pond watershed area as part of the Town's Phase 1 Core Program construction activities.

Adaptive Management Plan

The Draft CWMP includes an Adaptive Management Plan (AMP) that will report to MassDEP the results of the Town's annual ground water monitoring of the Tri-Town site and monitoring of water quality and eel grass coverage in Orleans' coastal embayments to document the reductions in watershed nitrogen loads achieved from the Town's phased sewer construction program. The AMP will assist the Town to evaluate the Town's compliance with established TDMLs and identify the need for adjustments or mid-course corrections to subsequent phases of the structural and non-structural components of the Core Program.

The SEIR should provide a detailed description of the Town's proposed AMP and its water quality monitoring program for the Tri-Town site and the coastal embayments surrounding the Town of Orleans. I encourage the Town to consult with the Pleasant Bay Resource Management Alliance in designing the Town's water quality monitoring program. The SEIR should also include a discussion of the Town's commitment to continue its freshwater pond assessment and restoration activities. I ask that the Town expand the distribution of its annual water quality monitoring report to also include the CCC and the Pleasant Bay Resource Management Alliance.

Wetlands

The SEIR should delineate on a plan of reasonable scale all environmental resources areas located within areas proposed for sewering including; wetlands, water bodies, drinking water supplies, sensitive habitats, fisheries, designated Areas of Critical Environmental Concern (ACEC), Article 97 lands, historic resources, and agricultural lands.

The SEIR should analyze both direct and indirect impacts on wetlands and water bodies resulting from the project, and quantify the amount of direct wetland impact. The analysis should also discuss the consistency of any proposed drainage and stormwater management systems that are included in the project with the MassDEP Stormwater Management regulations and the Wetlands Protection Act performance standards. Proposed activities, including construction mitigation, erosion and sedimentation control, phased construction, and drainage discharges or overland flow into wetland areas, should be evaluated.

The SEIR should identify all parcels that are currently deemed unbuildable within the 100-year flood plain that would potentially become buildable as a result of a sewer installation. The SEIR should provide detailed plans, at a suitable scale, illustrating the proposed project's impacts to wetland resource areas. The SEIR should examine alternatives that avoid impacts to wetland resource areas, their associated buffer zones, riverfront protection areas and 100-year flood plain areas. Where it has been demonstrated that impacts are unavoidable, the SEIR should demonstrate that the impacts have been minimized, and that the project will be accomplished in a manner that is consistent with the Performance Standards of the Wetlands Regulations (310 CMR 10.00). The Town will need to provide wetlands replication at a ratio of at least 1:1 for any unavoidable impacts to wetlands. For any amount of required wetlands replication, a detailed wetlands replication plan should be provided in the SEIR that, at a minimum, includes: replication location(s), elevations, typical cross sections, groundwater elevations, the hydrology of areas to be altered and replicated, list of wetlands plant species of areas to be altered and the proposed wetland replication species, planned construction sequence, and a discussion of the required performance standards and monitoring.

Rare Species

As described in the EENF, the existing Tri-Town Septage Treatment Facility site is located within Priority Habitat for the Eastern Box Turtle (*Terrapene carolina*), the Diamond-backed Terrapin (*Malaclemys terrapin*), Salt Reedgrass (*Spartina cynosuroides*) and Mitchell's Sedge (*Carex mitchelliana*). The EENF includes an evaluation of four alternative site layouts (Alternatives A-D) for the new WWTF facility. According to NHESP's comments on the EENF, the construction of the Orleans WWTF will occur within mapped habitat for the Eastern Box Turtle (Terrapene carolina). NHESP has recommended that the Town identify a site layout alternative that will maximize the reuse of existing disturbed areas and avoid fragmentation of undisturbed areas within the proposed Orleans WWTF site to avoid a 'take' of the Eastern Box Turtle, and I have included this requirement in the Scope for an alternatives analysis provided above.

The SEIR should include a detailed description of the Town's preferred site layout alternative for the Orleans WWTF. If NHESP should subsequently find that the project will require a Conservation Permit pursuant to the Massachusetts Endangered Species Act (MESA), the SEIR should analyze the impacts to Eastern Box Turtle and evaluate avoidance/mitigation strategies. I ask that the Town continue to work closely with NHESP and consult with the Orleans Conservation Commission during the preparation of this section of the SEIR and the final project design to identify necessary project construction and post-construction conditions and commitments to avoid an adverse impact to resource area habitats of state-listed species located within and adjacent to the Orleans WWTF site. The SEIR should report on the results of the Town's consultations with NHESP.

Historical/Archeological Resources

The Town should provide the MHC with a US Geological Survey topographical map that locates the Town's phased project area and scaled project plans showing existing and proposed conditions. These plans should be submitted to MHC as early as possible during the design phase corresponding to each of the proposed project development phases. In comments submitted on the EENF, the Massachusetts Historical Commission (MHC) indicated that a number of proposed pump stations are located within and/or adjacent to recorded archeological sites and archaeologically sensitive areas. The Town to coordinate with MHC to ensure review of any potential historic impacts from the project and the SEIR should provide an update on the status of these discussions. If MHC deems the project to have an "adverse effect" on historic or archaeological resources, the SEIR should include a discussion of mitigation measures that the Town will undertake to address the adverse effect.

Greenhouse Gas Emissions (GHG) and Sustainable Development

The project requires an EIR and therefore is subject to the requirements of the MEPA Greenhouse Gas Emissions Policy and Protocol ("the Policy"): http://www.mass.gov/envir/mepa/downloads/GHGPolicyRev1108.pdf . The policy requires project proponents to quantify the direct and indirect CO_2 emissions from the proposed project, including CO_2 emissions associated with the buildings & plant operations, and to compare those emissions to the project baseline, which includes no-build conditions as well as an assessment of the emissions associated with the current effective building code ("base case"). In connection with this requirement, the MEPA Office and the Department of Energy Resources (DOER) routinely schedule pre-filing meetings to provide technical assistance to proponents in the development of GHG analyses. I strongly encourage the Town to request a pre-filing meeting as it prepares the SEIR.

The policy requires proponents to use energy modeling software to quantify projected energy usage from stationary sources and energy consumption. The policy allows the proponent to select a model but, DEP and DOER recommend using EQUEST for stationary source modeling for buildings and building systems.

The SEIR should include the modeling printout for the base case and for the preferred alternative case. The SEIR should also present an evaluation of the feasibility of each of the mitigation measures outlined below, as well as the GHG emissions reduction potential associated with each measure. The SEIR should explain, in reasonable detail, any measure not selected- either because it is not applicable to the project or is considered technically or financially infeasible- that would result in a significant reduction of GHG.

Building Design

DOER has identified several building design measures worthy of consideration in the SEIR, and adoption into the project, where feasible.

- Building Orientation- The SEIR needs to clearly describe how the buildings will be oriented, why, and the expected impacts on energy usage including solar gain, day-lighting and effect on proposed and future solar energy collection systems;

- Duct Insulation- Duct insulation is the baseline required by code. To enhance efficiency, the SEIR should note, and construction should reflect, that all ducts will be sealed with mastic, tested and then insulated, since duct leakage can be a major factor in energy losses;

- Roof and Wall Insulation- The SEIR should evaluate using the highest R-value insulation possible. In general, providing the best building envelope possible provides the greatest gains in energy savings for building operations and insulation is generally very cost effective;

- High-Albedo Roofing Materials – The SEIR should fully consider these roofing materials, which are highly reflective and reduce cooling requirements for buildings. For roofing, USGBC provides LEED credit for low-slope roofs with a minimum SRI of 78 and for steep-slope roofs with a minimum SRI of 29. To qualify for an Energy Star label, Low Slope roofs must have an initial solar reflectance of at least 0.65. After 3 years, the solar reflectance must be at least 0.50. Steep Slope roofs must have an initial solar reflectance of at least 0.25, and at least 0.15 after 3 years. In addition, the performance of solar PV systems is improved when mounted on high albedo roofs; and,

- On-site renewable energy – At a minimum, buildings should be oriented and roofs should be constructed to support the added weight of a solar photovoltaic (PV) system for potential installation during project construction or at a future date. It should be noted that a rooftop PV system operates even more efficiently, due to added reflectivity, when installed on a high-albedo roof.

  Considering the support of subsidies through the Commonwealth Solar and RPS programs, the SEIR should include a life-cycle cost analysis should be done to evaluate the installation of a PV system during project construction under two scenarios: 1) construction, ownership and operation of a PV system by the building owner; or 2) construction, ownership, and operation of a PV system by a third party that will then enter into a long-term power purchase agreement with the building owner for the electricity produced by the system. If neither of these scenarios is economically feasible at this time, the Town should continue to consider the opportunity for installing PV at a future date and state its willingness to host a third-party owned PV array under a favorable power purchase agreement. The following website provides information on the Commonwealth Solar program and tools for performing basic life cycle cost analyses: http://www.masstech.org/renewableenergy/commonwealth_solar/index.html#

Equipment Design

The Town should explore and present modeling results in this section of the SEIR related to the use of renewable and energy efficient equipment listed below when designing new or upgraded wastewater treatment facilities, pump stations and other components of the Town's comprehensive wastewater management system.

- The SEIR should specify premium class rated motors for any new or replacement pumps, fans, or other drives larger than 1 horsepower (HP), as well as any scheduled to be upgraded;

- The SEIR should specify the use of high efficiency models for new and replacement pumps, blowers, agitators, or other rotating equipment;

- The SEIR should consider Variable Frequency Drives (VFDs) for all motors larger than ten HP;

- The SEIR should include an analysis to determine the combination of pumps (both size

and type), controls and piping which will result in a system configuration which will operate at the highest average efficiency;

- The SEIR should fully consider the inclusion of renewable energy systems, such as photovoltaic panels, which could be ground mounted, to reduce the indirect CO_2 emissions due to the fossil fuel generated electricity which would otherwise be used;

- The SEIR should evaluate sizing, routing, and material selection for the extension of pumped sewer lines which will result in reducing the average pumping power required for the transfer of the sewer flow;

- The SEIR should include a detailed discussion of the design principles and measures which will result in reduced indirect GHG emissions that will be implemented should any of the satellite stations be constructed; and,

- The SEIR should include a description of the maintenance and replacement policies, activities and schedules related to equipment included in existing system pumping stations which will eventually bring them to a comparable standard of efficiency.

I note that MassDEP, in coordination with other state and local agencies has initiated a demonstration project to retrofit existing wastewater treatment plants and water treatment plants with energy efficient technology, **http://www.mass.gov/dep/water/wastewater/empilot.htm.** The costs of some of these improvements are eligible for funding through the SRF and other programs. I encourage the Town to consult with MassDEP regarding this demonstration project as it prepares the analysis required under this section.

Construction Impacts

Construction period impacts and mitigation measures should be described in the SEIR, including impacts from noise and dust, impacts on trees and other vegetation, and traffic impacts. Measures that will be taken to minimize and mitigate construction period impacts (in particular impacts on sensitive receptors or exceptional resources) should be detailed.

Sewering and Growth Management

The EENF/Draft CWMP includes a discussion of potential land use control mechanisms to limit unwanted secondary growth related to the construction of the Town's Core sewering project. The Town is proposing to implement a "checkerboard" sewer connection bylaw that will enable the Town to select specific lots that will be connected to the municipal sewer system and lots that do not need sewering and therefore will not be allowed to connect to the new sewer system. The Town is also proposing to implement a 'flow-neutral' nutrient control regulation, to be administered through the Orleans Board of Health, which would limit the redevelopment of existing properties by restricting the amount of additional wastewater flow/nitrogen load from the redeveloped property to the amount of wastewater flow the property is currently allowed under Title 5 and local zoning.

The SEIR should identify parcels located within the proposed sewer service areas and compare the potential secondary growth impacts, water use and increased wastewater flows that may be induced by public sewers and expected reductions of water use and wastewater flows with the Town's proposed growth management policies, regulations and bylaws. The SEIR should include copies of any new by-laws or regulations proposed by the Town for controlling new future development requesting municipal sewer service and located in areas outside of the proposed new sewer areas. The Town should consider adopting and implementing any proposed growth by-laws, regulations, and policies prior to the construction of any new sewers.

Costs to Homeowners

As described in the EENF/Draft CWMP, the Core Program will be constructed in six phases over 15-20 years and will cost an estimated $150,000,000. The estimated operation and maintenance costs for the proposed Core Program total approximately $1.4 million dollars. The Town proposes to recover 80% of the project debt service through user and non-user property taxation and 20% through betterment assessments to be paid by users of the sewer system. The EENF provides estimates for the average (capital and O&M) for households connected to the sewer system ($2,592.00) and households not connected to the sewer service area ($2,544.00).

The SEIR should include estimates for the costs of land acquisition associated with the proposed cluster treatment plants and corresponding groundwater disposal sites. The SEIR should document any assumptions concerning the probable cost of acquiring parcels for wastewater purposes. The Town should consult with MassDEP during the preparation of this section of the SEIR.

Future Sewer Expansion

The Town's Core Program has been designed to accommodate potential future expansion to serve the remaining unsewered areas of Orleans under the Expanded Program and/or additional wastewater flows from the neighboring towns of Eastham and Brewster under the Regional Program.

Expanded Program

The Expanded Program would provide town-wide sewers in Orleans and would cost an additional $95 million dollars. However, as described in the EENF and noted elsewhere in this Certificate, additional wastewater disposal sites or reuse options may be required to support the treatment and disposal of additional wastewater flows anticipated under the Expanded Program or the Regional Program described below. The SEIR should evaluate the Tri-Town site's capacity to treat the additional estimated wastewater flows to be generated under the Expanded and the Regional wastewater treatment alternatives.

Regional Program

I commend the Town for undertaking the Regional Economies of Scale study of potential regional approaches to address the wastewater treatment and disposal needs for the Towns of Orleans, Eastham and Brewster, and the regional issues pertaining to nutrient loading, wastewater treatment and disposal affecting the Nauset Marsh/Town Cove and Pleasant Bay coastal embayments. I ask the Town of Orleans, together with the Towns of Eastham to the north and Brewster to the south to work together with MassDEP, the Cape Cod Commission and others to continue the discussion of possible opportunities to integrate the Town of Orleans' wastewater treatment planning efforts with the planning efforts being undertaken by the Towns of Eastham and Brewster. In a separate section of the SEIR, the Town should include an update of the Regional Economies of Scale study to identify regional strategies for reducing the nutrient loading to coastal embayments and freshwater ponds in Orleans, Eastham and Brewster.

Public Participation

I note that the State's Revolving Fund (SRF) regulations require the proponent to conduct a minimum of one public meeting and one public hearing for this project. The SEIR should include a discussion of the Town's public participation program activities completed and proposed to date.

Mitigation/Section 61

The SEIR should include a separate chapter on mitigation measures. This chapter on mitigation should include Draft Section 61 Findings for all state agency actions. The Draft Section 61 Findings should contain a clear commitment to mitigation, an estimate of the individual costs of the proposed mitigation and the identification of the parties responsible for implementing the mitigation. A schedule for the implementation of mitigation should also be included. I ask the Town to continue to work closely with CCC, MassDEP, and the Pleasant Bay Resource Management Alliance to design and implement a sustainable Comprehensive Wastewater Facilities Plan and mitigation plan for the Town of Orleans that will help to offset the proposed project's municipal sewering impacts.

Comments

The SEIR/Final CWMP should respond to the comments received. I recommend that the Town use either an indexed response to comments format, or else direct narrative response. The SEIR should present any additional narrative or quantitative analysis necessary to respond fully to the comments received. This directive is not intended to, and shall not be construed to, enlarge the scope of the SEIR beyond what has been expressly identified in this Certificate.

Circulation

The Final SEIR/Final CWMP should be circulated in compliance with Section 11.16 of the MEPA regulations and copies should also be sent to the list of "comments received" below and to town officials from the Towns of Orleans, Eastham and Brewster. A copy of the SEIR should be made available for public review at the Orleans, Eastham and Brewster Public Libraries.

July 10, 2009
DATE

Ian A. Bowles, Secretary

Comments received: (continued on next page)

05/18/09 Massachusetts Historical Commission (MHC)

Comments received: (continued)

06/10/09 Cape Cod Commission (CCC)
05/21/09 Division of Marine Resources
06/08/09 Pleasant bay Resource Management Alliance
06/18/09 Town of Orleans
06/24/09 Natural Heritage & Endangered Species Program (NHESP)
06/29/09 Department of Conservation and Recreation (DCR)
06/30/09 MA Department of Environmental Protection (MassDEP) – SERO
07/01/09 Mary Hartley

EENF #14414
IAB/NCZ/ncz

ATTACHMENT 5

NPC Distribution List

NPC Distribution List
Comprehensive Wastewater Management Plan

Secretary Mathew A. Beaton
Executive Office of Energy & Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

Massachusetts Department of Environmental Protection
Commissioner's Office
One Winter Street
Boston, Massachusetts 02108

MA DEP – Southeast Regional Office
Attn: MEPA Coordinator
20 Riverside Drive
Lakeville, MA 02347

Massachusetts DOT District #5 Office
Attn: MEPA Coordinator
Box 111
1000 County Street
Taunton, MA 02780

Massachusetts Historical Commission
220 Morrissey Boulevard
Boston, MA 02125

Cape Code Commission
P.O. Box 226
3225 Main Street
Barnstable, MA 02630

Natural Heritage and Endangered Species Program
Commonwealth of Massachusetts
1 Rabbit Hill Road
Westborough MA 01581

Department of Conservation and Recreation
Attn: MEPA Coordinator
251 Causeway Street Suite 600
Boston MA 02114

Division of Marine Fisheries (South Shore)
Attn: Environmental Reviewer
836 South Rodney French Blvd
New Bedford, MA 02744

Massachusetts Department of Energy Resources
100 Cambridge St.
Suite 1020
Boston, MA 02114

Town of Orleans Planning Board
19 School Road
Orleans, MA 02653

Town of Orleans Board of Selectmen
19 School Road
Orleans, MA 02653

Town of Orleans Board of Health
19 School Road
Orleans, MA 02653

Town of Orleans Conservation Commission
19 School Road
Orleans, MA 02653

Pleasant Bay Alliance
P.O. Box 1584
Harwich, MA 02645

Coastal Zone Management
Attn: Project Review Coordinator
251 Causeway Street, Suite 800
Boston, MA 02114

Department of Public Health (DPH)
Director of Environmental Health
250 Washington Street
Boston, MA 02115

Sierra Club
Massachusetts Chapter
50 Federal Street
Boston, MA 02110
Attn: Cape Cod and the Islands Group/David Dow

Town of Brewster
Comprehensive Water Planning Committee
2198 Main Street
Brewster, MA 02631

Clean Water Action
1010 Vermont Avenue, Suite 1100
Washington, DC 20005

Orleans Pond Coalition
P.O. Box 2485
Orleans, MA 02653

Eastham Board of Selectmen
2500 State Highway
Eastham, MA 02642

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88 Rock Harbor Road
Orleans, MA 02653

Beverly M. Carney
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